



October 6, 2014

Ms. Shelly Lam
Federal On-Scene Coordinator
U.S. Environmental Protection Agency Region 5
2525 N. Shadeland Avenue, Suite 100
Indianapolis, IN 46219

**Subject: Final Sampling and Analysis Plan
West Vermont GW Contamination Site
Speedway, Marion County, Indiana
EPA Identification Number (No.) INN000510429
EPA Contract No. EP-S5-13-01 (START IV, Region 5)
EPA Technical Direction Document (TDD) No. 0001-1404-009
Document Tracking No. (DTN): 0068**

Dear Ms. Lam:

The Tetra Tech, Inc. Superfund Technical Assessment and Response Team (START) is submitting the final sampling and analysis plan (SAP) for the West Vermont Groundwater (GW) Contamination site in Speedway, Marion County, Indiana. The SAP summarizes the groundwater sampling event planned for the last two weeks of October 2014, and includes figures (Appendix A), tables (Appendix B), and the Tetra Tech, Inc. Standard Operating Procedures (Attachment 1). The proposed technical approach has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) Performance Work Statement for the subject contract.

Please call me at (312) 201-7739 if you have any questions or comments regarding this submittal.

Sincerely,

A handwritten signature in blue ink, appearing to read 'K. Scott'.

Kevin Scott
START IV Project Manager

Enclosures (2)

cc: TDD file

**FINAL
SAMPLING AND ANALYSIS PLAN**

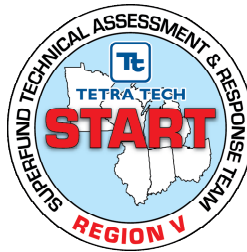
**WEST VERMONT GW CONTAMINATION SITE
SPEEDWAY, MARION COUNTY, INDIANA**



U.S. EPA ID NO. INN000510429

Revision 0

Prepared for

**U.S. ENVIRONMENTAL PROTECTION AGENCY
Region 5
Chicago, Illinois 60604**



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EPA OSC:	Shelly Lam
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SAMPLING DATES:	October 2014
SAP PREPARER:	Kevin Scott
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QC REVIEWER:	John Dirgo
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Attachment

- 1 TETRA TECH, INC. STANDARD OPERATING PROCEDURES

ACRONYMS AND ABBREVIATIONS

µg/L	Micrograms per liter
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Lab Program
DCE	1,2-Dichloroethene
DTN	Document tracking number
DQO	Data quality objectives
EDD	Electronic Data Deliverable
EPA	U.S. Environmental Protection Agency
ESAT	Environmental Services Assistance Team
GIS	Geographic Information System
gpm	Gallon per minute
GPS	Global Positioning System
HASP	Health and Safety Plan
HRS	Hazard ranking system
IDEM	Indiana Department of Environmental Management
IDW	Investigation-derived waste
L/min	Liter per minute
MCL	Maximum contaminant level
MCPHD	Marion County Public Health Department
MS/MSD	Matrix spike/matrix spike duplicate
No.	Number
NTU	Nephelometric turbidity units
OSC	On-Scene Coordinator
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
PCE	Tetrachloroethylene
pdf	Portable document format
PPE	Personal protective equipment
PRP	Potentially responsible party
RAL	Removal Action Level
Ref.	Reference
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SOP	Standard Operating Procedure
SOW	Statement of work
START	Superfund Technical Assessment and Response Team
SU	Standard unit
TCE	Trichloroethylene
TCL	Target Compound List
TDD	Technical Direction Document
Tetra Tech	Tetra Tech, Inc.
VC	Vinyl chloride
VOC	Volatile organic compound
W. Vermont GW	West Vermont Groundwater

1.0 INTRODUCTION

Under Contract Number (No.) EP-S5-13-01, Technical Direction Document (TDD) No. 0001/S05-0001-1404-009, the U.S. Environmental Protection Agency (EPA) directed the Tetra Tech, Inc. (Tetra Tech) Superfund Technical Assessment and Response Team (START) to prepare a sampling and analysis plan (SAP) for a groundwater sampling event at the West Vermont Groundwater Contamination (W. Vermont GW) site located in Speedway, Marion County, Indiana (EPA Identification No. INN000510429). The purpose of the SAP is to specify the type, number, and location of samples to be collected during the sampling event, as well as the sampling methodology.

All activities and procedures discussed and described in this SAP will be conducted in accordance with Tetra Tech's April 2014 START Quality Assurance Project Plan (QAPP) to ensure that all data quality objectives (DQO) are met (Reference [Ref.] 1). The primary purpose of this work is to evaluate the relative threat to public health and the environment posed by releases of hazardous substances from the site. Information obtained from these sampling activities will be referenced to generate a preliminary Hazard Ranking System (HRS) score for the site. The data also will be used to determine the need for additional activities at the site under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and the Superfund Amendments and Reauthorization Act of 1986 (SARA) — including possible preparation of an HRS package to propose the site for inclusion on the National Priorities List.

Activities at the W. Vermont GW site will include the following:

- Obtain and review relevant file material;
- Collect samples to establish background levels;
- Collect samples to attribute hazardous substances to potentially responsible party (PRP) contamination sources;
- Prepare geographic information system (GIS) maps; and
- Prepare draft and final site investigation reports that summarize the findings of the sampling event.

The remainder of this SAP for the W. Vermont GW site is organized as follows:

- Section 2.0 presents the site background including the site location and layout, site history, and previous investigations.
- Section 3.0 summarizes the proposed sampling, including the scope of work, field sampling activities, sample handling, and equipment decontamination.
- Section 4.0 describes the analytical methodology.
- Section 5.0 summarizes the quality assurance and quality control (QA/QC) procedures.

- Section 6.0 discusses disposal of investigation-derived waste (IDW).
- Section 7.0 presents the project personnel, including the field team and its responsibilities.
- Section 8.0 describes the deliverables.
- Section 9.0 provides the project schedule.
- Section 10.0 provides a list of references.
- Appendix A provides figures.
- Appendix B provides tables.
- Attachment 1 provides the Tetra Tech Environmental Standard Operating Procedures (SOP).

2.0 SITE BACKGROUND

This section describes the site location and layout, presents the site history, and summarizes previous investigations conducted at the W. Vermont GW site.

2.1 SITE LOCATION AND LAYOUT

The site is located in the Town of Speedway and the City of Indianapolis, Wayne Township, Marion County, Indiana (see Figure 1 in Appendix A). The Study Area for this investigation includes five separate but nearby locations: a Residential Area, three PRP properties (GM Allison Transmission, Genuine Auto Parts, and Michigan Plaza), and the Maple Creek Village Apartments (see Figure 2 in Appendix A). The residential area is a neighborhood bounded by West Vermont Street to the south, North Holt Road to the east, West Michigan Street to the north, and North Rybolt Avenue to the west. The geographic coordinates are latitude 39.775472 degrees north and longitude 86.233686 degrees west (as measured from the approximate center of the site) (see Figure 1 in Appendix A).

2.2 SITE HISTORY

In 2009, the Marion County Public Health Department (MCPHD) identified a neighborhood where 25 homes not connected to a municipal water system were using private drinking water wells. MCPHD collected water samples from several of the residential drinking water wells to evaluate water quality. Three sample results from residential wells contained vinyl chloride (VC) detections at concentrations exceeding the EPA Maximum Contaminant Level (MCL) and Superfund Removal Action Level (RAL) of 2 micrograms per liter ($\mu\text{g/L}$). Subsequent sample results for these three residential wells confirmed VC contamination (Ref. 2).

In October 2009, the Indiana Department of Environmental Management (IDEM) formally requested assistance from EPA for this site. In November 2009 and February 2010, the EPA installed temporary water treatment systems in the three residences. In 2010, EPA conducted groundwater gauging to determine groundwater flow direction in the Study Area. The EPA directed START to collect groundwater samples from six drinking water wells in the Residential Area and four existing monitoring wells in the Study Area. The samples were analyzed for volatile organic compounds (VOCs), ethane, ethene, and volatile fatty acids. Ethene and ethane results were obtained to determine if VC was being reductively dechlorinated. CAP 18 ME, a refined, food-grade vegetable oil, was injected into the groundwater to enhance the biodegradation of volatile contaminants at the Michigan Plaza property. Volatile fatty acids are a breakdown product of CAP 18 ME, and samples were collected to determine if reductive dechlorination associated with the CAP 18 ME injections was occurring. As a result of these activities, the EPA identified one additional residential drinking water well with a VC concentration

above the MCL and RAL (Ref. 3). However, during all other times that MCPHD sampled this fourth residential property, VC concentrations were below the MCL and RAL. Therefore, EPA did not install a treatment system at this fourth residential property (Ref. 2).

Three PRP properties were identified as potential sources of contamination in the Residential Area: Allison Transmission, Genuine Auto Parts (also known as the Former Allison Transmission Plant 10), and Michigan Plaza (see Figure 2 in Appendix A).

2.3 PREVIOUS INVESTIGATIONS

Previous investigations have shown that contamination from the Genuine Auto Parts property has migrated beyond the Genuine Auto Parts property and Little Eagle Creek to the south, southwest, and southeast. Groundwater results from January 2002 indicate that a VC plume extended from the Genuine Auto Parts property south to monitoring well MW-170D (Ref. 4). VC concentrations ranged from 1,500 µg/L near the Genuine Auto Parts property to 80 µg/L in MW-170D to the south-southwest. Well MW-170D is located about 200 feet northeast of contaminated residential wells and indicates the presence of VC in the vicinity of the Residential Area as early as 2002. However, there are no groundwater data from MW-170D between 2002 and 2007 (Ref. 2).

3.0 PROPOSED SAMPLING PLAN

The objective of this sampling event is to collect groundwater samples from the site, including drinking and non-drinking water sources, to determine the environmental impacts or threat caused by the potential source(s) of contamination.

3.1 SCOPE OF WORK

During the sampling event, Tetra Tech will complete the following tasks:

- Collect groundwater samples from each of 28 existing permanent monitoring wells, including three field duplicate samples and two matrix spike/matrix spike duplicate (MS/MSD) samples for QA/QC purposes.
- Collect drinking water samples from two nearby (downgradient) residential target wells and background residential wells (upgradient) including one field duplicate sample, and one MS/MSD sample for QA/QC purposes.
- Document water quality parameters during the collection of groundwater samples from the monitoring and drinking water wells and piezometers.
- Collect trip blanks, one field blank, and one equipment rinsate blank for QA/QC purposes.
- Conduct written and photographic documentation of the site investigation. The locations of the groundwater and drinking water samples will be recorded with a global positioning system (GPS) instrument during sampling activities.
- Package and ship all groundwater, drinking water, and IDW samples to an EPA Contract Laboratory Program (CLP) laboratory for analysis of Target Compound List (TCL) VOCs including tetrachloroethylene (PCE), trichloroethylene (TCE), 1,2-Dichloroethene (DCE), and VC
- Package and ship all groundwater and drinking water samples to a non CLP laboratory for analysis for dissolved gases including methane, ethane, and ethene.
- Prepare and submit a report that summarizes all field activities and validated analytical data. The report will compare the data with background concentrations and appropriate pathway-specific benchmarks, as well as comparison criteria. Tetra Tech will also prepare a map with all sampling locations and field observations.

The Tetra Tech field team leader and the EPA On-Scene Coordinator (OSC) may change sampling locations and the number of samples to be collected in response to site conditions at the time of the sampling event. Samples will be collected, along with QA/QC samples, in accordance with procedures documented in Tetra Tech's April 2014 START QAPP (Ref. 1). Figure 3 in Appendix A depicts the site layout and proposed sampling locations. Table 1 in Appendix B describes the sample types and nomenclature, and provides a general description of the proposed sampling locations. Table 2 in Appendix B provides the QA/QC samples. Table 3 in Appendix B provides the analytical methods. Table 4 in Appendix B provides the number of samples to be collected per media. Attachment 1 provides the Tetra Tech SOPs. The analytical methodology is described in Section 4.0 of this SAP.

3.2 GROUNDWATER SAMPLING

Tetra Tech will collect groundwater samples from 28 existing groundwater monitoring wells (see Figure 3 in Appendix A). Three field duplicates and two MS/MSD samples also will be collected for QA/QC purposes. Data collected during purging and sampling will be documented on a sample-specific field log sheet. Recorded parameters will include water level, temperature, pH, specific conductance, and turbidity. Other parameters that will be recorded on field log sheets during purging include discharge rate and cumulative discharge volume.

Groundwater samples will be preserved with the appropriate preservative and shipped to the EPA CLP Laboratory (TCL VOCs) and non-CLP laboratory for analysis. Tetra Tech will use a peristaltic pump to conduct low-flow micropurge groundwater sampling in accordance with Tetra Tech SOP No. 015-1, “Groundwater Sample Collection Using Low-Flow Sampling Methodology” (Ref. 6). Typically, the discharge rate will be less than 0.5 liter per minute (L/min) (0.13 gallon per minute [gpm]). The maximum purge rate will not exceed 1 L/min (0.25 gpm) and will be adjusted to achieve minimal drawdown. The purge and rinsate water used at the site will be collected, containerized, and properly disposed of as IDW. The purge and rinsate water will be stored in drums on site until final disposal is determined by EPA (see Section 6.0).

Water quality and purge stabilization parameters (including pH, temperature, and specific conductance) will be measured using a water quality meter, such as a Horiba, YSI, or other multi-parameter meter coupled with a flow-through cell. Water quality measurements will be collected in accordance with Tetra Tech SOP No. 061-2, “Field Measurement of Groundwater Indicator Parameters” (Ref. 7).

Turbidity measurements will be recorded concurrently with the other water quality parameters using a portable turbidity meter, such as a LaMotte or HF Scientific turbidity meter, in accordance with Tetra Tech SOP No. 88-1, “Field Measurement of Water Turbidity” (Ref. 8). The water level in the well and effluent flow rate will be periodically monitored throughout the purging of the well at 5-minute intervals.

In accordance with Tetra Tech SOP No. 015-1, well purging will continue until water quality parameters stabilize so the monitored chemistry values do not fluctuate more than the following ranges over three successive readings at 5-minute intervals: ± 0.1 pH unit; ± 3 percent for specific conductance; and ± 10 percent for turbidity (Ref. 6). Once water quality parameters have stabilized, Tetra Tech will collect a groundwater sample directly from the sample/purging tubing after disconnecting the tubing from the flow-through cell. The groundwater sample will be immediately collected from the tubing into the appropriate certified-clean sample containers identified for each analysis. Tetra Tech will first collect the sample for VOC analysis by placing the groundwater directly into three preserved 40-milliliter glass vials

with septum lids. After the sample for VOC analysis has been collected, Tetra Tech will collect additional volume for the other analyses. The total well depths will be measured before sampling at each well in accordance with Tetra Tech SOP 014-1, “Static Water Level, Total Well Depth, and Immiscible Layer Measurement” (Ref. 9).

Groundwater samples will be analyzed for TCL VOCs and methane, ethane, and ethene (see Table 1 in Appendix B).

3.3 DRINKING WATER WELL SAMPLING

Tetra Tech will collect drinking water samples (including two target locations, two background locations, one field duplicate, and one MS/MSD for QA/QC purposes) from four private wells (see Figure 3 in Appendix A). The samples will be collected in accordance with EPA Region 4 SOP No. SESDPROC-305-R3, “Potable Water Supply Sampling” (Ref. 10).

Drinking water samples will be preserved with the appropriate preservative and shipped to the EPA CLP Laboratory and non-CLP laboratory for analysis. Drinking water samples will be analyzed for TCL VOCs and methane, ethane, and ethene (see Table 1 in Appendix B).

Tetra Tech will follow these procedures, where it is possible, to locate the pressure tank and obtain access to an outside spigot (SESDPROC-305-R3):

- (1) Note the presence of any paints, solvents, glues, pesticides, herbicides, fuels, air conditioning, or other materials that may affect the result of the groundwater sample.
- (2) Locate the pressure tank and examine the water system; note size of pressure tank and any treatment system (such as a water softener).
- (3) Ideally, collect the sample from a tap or spigot located at or near the well head or pump house and before the water supply is introduced into any storage tanks or treatment units. If the sample must be collected at a point in the water line beyond pressurization or a holding tank, a sufficient volume of water should be purged to provide a complete exchange of fresh water into the tank or at the location where the sample is collected. If the sample is collected from a tap or spigot located just before a storage tank, spigots located inside the building or structure should be turned on to prevent any backflow from the storage tank to the sample tap or spigot. It is generally advisable to open several taps during the purge to ensure a rapid and complete exchange of water in the tanks.
- (4) Purge the system for at least 15 minutes when possible. During the purge period, obtain at least three sets of readings as follows: after purging for several minutes, measure the pH, specific conductivity, temperature, and turbidity of the water. Continue to measure the parameters to assess for stabilization. Stabilization occurs when at least three consecutive measurements show: the pH remains constant within 0.1 standard unit (SU); specific conductance varies no more than approximately 10 percent; and the temperature is constant. No set criteria establish how many total sets of measurements are adequate to document the stability of these parameters. An adequate purge is achieved when the pH, specific conductance, and temperature of the potable

water have stabilized and the turbidity has either stabilized or is below 10 nephelometric turbidity units (NTU) (twice the primary drinking water standard of 5 NTUs).

- (5) Samples may be collected after three sets of readings have been obtained. If stabilization has not occurred after the 15-minute purge period, it is at the discretion of the field team leader to collect the sample or continue purging and monitoring the parameters. This decision would depend on the condition of the system and the specific objectives of the site investigation.
- (6) After sample collection, all samples requiring preservation must be preserved as soon as practical. Samples that require reduced temperature storage should be placed on ice immediately.

If no outside spigot is available, Tetra Tech will use the following procedure (SESDPROC-305-R3):

- (1) Purge the system by opening an inside faucet and allowing water to run for at least 15 minutes so that the well pump is activated and the system has completely flushed. If possible, disconnect any hoses, filters, or aerators attached to the tap before sampling. These devices can harbor a bacterial population if they are not routinely cleaned or replaced when they are worn or cracked.
- (2) Taps where the water flow is not constant should be avoided because temporary fluctuation in line pressure may cause clumps of microbial growth lodged in a pipe section or faucet connection to break loose. A smooth-flowing water stream at moderate pressure without splashing should be used. The sample should be collected without changing the water flow. It may be appropriate to reduce the flow from the VOCs aliquot to minimize sample agitation.

3.4 SAMPLE HANDLING

Samples will be handled, packaged, and shipped to their respective laboratories in accordance with Tetra Tech SOP No. 019-6, “Packaging and Shipping Samples” (Ref. 11). All groundwater, including drinking water, will be shipped to the EPA CLP laboratory for TCL VOCs analyses and to a non-CLP laboratory for methane, ethane, and ethene. All sampling data, including sample times, dates, locations, types, and samplers, will be recorded on SCRIBE (EPA software tool) chain-of-custody and traffic reports and in the site logbook in accordance with Tetra Tech SOP No. 024-1, “Recording of Notes in Field Logbook” (Ref. 12). The Tetra Tech field team leader will ensure that sample quality and integrity are maintained in accordance with Tetra Tech’s START April 2014 QAPP (Ref. 1).

3.5 EQUIPMENT DECONTAMINATION

Dedicated sampling equipment and personal protective equipment (PPE) will be double-bagged and disposed of with all other used PPE waste produced at the site. Non-dedicated sampling equipment will undergo decontamination with Liquinox and distilled water followed by a double rinse with distilled water, in accordance with Tetra Tech SOP No. 002-3, “General Equipment Decontamination” (Ref. 13).

4.0 ANALYTICAL METHODOLOGY

Groundwater, including drinking water samples, will be analyzed for TCL VOCs by the EPA CLP Laboratory. Level IV data packages will be requested from each laboratory. Table 1 in Appendix B provides the sample numbers, types, analyses, locations, and rationales. Table 2 in Appendix B provides the QA/QC samples. Table 3 in Appendix B summarizes analytical parameters, including the sample matrices, analytical methods, sample containers and preservatives, and maximum holding times for the samples collected during this sampling event. Table 4 in Appendix B provides the number of samples to be collected per media.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL PROCEDURES

This section describes the DQOs and the QA/QC procedures for the sampling event at the W. Vermont GW site. Specifically, this section addresses responsibilities, field QC, laboratory QC, data validation, and data evaluation and management for the sampling event. See the Tetra Tech April 2014 START QAPP for additional information (Ref. 1).

5.1 RESPONSIBILITY

The Tetra Tech field team leader, Mr. Keith Hughes, will be responsible for ensuring that sample quality and integrity are maintained in accordance with the Tetra Tech April 2014 START QAPP (Ref. 1). EPA will be responsible for obtaining access to the site and off-site sampling locations. Tetra Tech will provide support with obtaining access to properties, as directed.

5.2 FIELD QUALITY CONTROL

Tetra Tech personnel will perform sample documentation of field QC measures as described in the Tetra Tech April 2014 START QAPP and Tetra Tech SOP No. 024-1, "Recording of Notes in Field Logbook" (Refs. 1; 13). Field QC measures will consist of collecting aqueous trip blanks, one equipment rinsate blank, and one field blank. Trip blanks will be collected to evaluate whether unknown site conditions or sample handling procedures are influencing analytical results. One trip blank will be submitted with each sample shipment for VOC analysis only. The equipment rinsate blank sample will be collected to evaluate whether decontamination procedures adequately clean sampling equipment. One equipment rinsate blank will be submitted for each type of equipment used. The field blank will be submitted to evaluate the potential for contamination of a sample from sources not associated with sample collection (ambient conditions). One field blank will be submitted for each lot of high-purity, final rinse water used. One field duplicate sample will be collected for every 10 samples and one MS/MSD sample will be collected for every 20 samples collected per matrix (see Table 2 in Appendix B).

5.3 LABORATORY QUALITY CONTROL

All groundwater, including drinking water and IDW samples, will be shipped to the EPA CLP laboratory for TCL VOCs. Groundwater, including drinking water, samples will be shipped to a non-CLP laboratory for methane, ethane, and ethene analyses. Laboratory QC measures will consist of all QC elements identified in each laboratory's procurement statement of work (SOW) and will include completing all forms and deliverables required in the SOW.

5.4 DATA VALIDATION

Data validation of CLP data will be performed by EPA's Environmental Services Assistance Team (ESAT) contractor. Data validation of non-CLP data will be performed by Tetra Tech.

5.5 DATA EVALUATION AND MANAGEMENT

This section describes how Tetra Tech will: (1) evaluate the data generated from the sampling event, (2) determine whether the data are representative of site conditions and complete enough for use in making confident risk management decisions, and (3) ensure that the data are secure and retrievable.

5.5.1 Data Evaluation

Tetra Tech will review the analytical packages to determine whether any major deficiencies were encountered during analysis and to ensure that the data are interpreted correctly. Groundwater and drinking water samples will be compared with the EPA MCLs (Ref. 5).

5.5.2 Data Representativeness and Completeness

This SAP is designed to obtain data representative of site conditions. If sampling activities vary significantly from this SAP because of unexpected field conditions or other unforeseeable factors, Tetra Tech will discuss how those variations affect data representativeness with the EPA OSC and will include a discussion of the matter in the site investigation report.

5.5.3 Data Management

Level IV data packages will be requested from each laboratory. Tetra Tech will request that the laboratories submit the analytical data in electronic data deliverable (EDD) form, as well as in the required portable document format (pdf) analytical data package. Tetra Tech will compare the EDDs with the pdf data package to ensure their consistency. When the Tetra Tech chemist has approved the data set with the appropriate data qualifiers, the electronic data will be released to the Tetra Tech project manager for reporting. Tetra Tech will use the data to prepare the site investigation report for the project. All electronic data will be stored in a SCRIBE database for future retrieval and reference based on the OSC's requirements. Each pdf copy of the data packages will be kept in the project file in the Tetra Tech office in Chicago, Illinois, until the data packages are officially transferred to EPA.

6.0 DISPOSAL OF INVESTIGATION-DERIVED WASTE

IDW will generally consist of disposable latex gloves, plastic bags, aluminum pans, and Tyvek. These items are used mainly for sample collection, to prevent cross-contamination, and to provide personal protection and sanitary conditions during sampling. If contact with concentrated wastes occurs, disposable gear and sampling supplies will be secured at a predetermined location in a 55-gallon drum until sample analytical results are received. IDW consisting of decontamination water and groundwater purged before sampling will be containerized in 55-gallon drums and staged at a predetermined location until sample analytical results are received. Composite aqueous samples will be collected from the IDW drums and analyzed for TCL VOCs. Analytical results for these samples will determine the appropriate disposal method for the IDW in accordance with the EPA IDW Management Guidance Manual (Ref. 15). If analytical data reveal contamination at levels that require special handling, these wastes will be disposed of by a licensed transport and disposal firm. Tetra Tech will make every effort to profile drum contents, procure a transport and disposal firm, and remove the drums from the site before demobilizing. However, if necessary, up to 3 months will be allowed to complete the drum profile and procure a transport and disposal firm.

If, in the best professional judgment of the field team leader, disposable IDW can be rendered nonhazardous, disposable IDW will be double-bagged and deposited in an industrial waste container as directed in the EPA IDW Management Guidance Manual (Ref. 15). IDW generated from equipment decontamination and monitoring well purging that is determined to be nonhazardous will be disposed of by an approved disposal firm.

7.0 PROJECT PERSONNEL

The Tetra Tech project manager for this TDD is Mr. Kevin Scott. Mr. Scott will be responsible and accountable for all aspects of the project scope of work, including achieving the technical, financial, and scheduling objectives for the project. Mr. Scott will communicate directly with the EPA OSC for this project, Ms. Shelly Lam. Anticipated Tetra Tech field team members and their responsibilities are as follows:

Project Function	Name	Role
Field Team Leader	Keith Hughes	Responsible for implementing all activities identified in the TDD; responsible for developing and implementing the site health and safety plan; has authority to commit resources necessary to complete the work; prepares deliverables required by the TDD; communicates directly with the EPA OSC, the project manager, the project team, and any other personnel needed to complete the project.
Field Support Personnel	To Be Determined	Performs necessary sampling or monitoring, as well as other tasks defined in the TDD or assigned by the EPA OSC or the Tetra Tech field team leader; communicates directly with the Tetra Tech field team leader and, when appropriate, the EPA OSC.
Health and Safety Officer	Chris Draper	Oversees and supports development of the site health and safety plan; communicates directly with the Tetra Tech project manager and field team leader to ensure that all corporate health and safety protocols applicable to the site are being followed.
Chemist	Jessica Vickers	Coordinates with the Tetra Tech project manager regarding the analytical requirements for the project; solicits and procures necessary laboratory services; reviews and validates analytical data, if necessary; communicates directly with the Tetra Tech project manager, field team leader, field support personnel, EPA OSC, and START program manager as necessary.
Graphics and Mapping Specialist	Maggie Banh	Generates maps and other figures for project deliverables or presentations; assists the Tetra Tech project manager or other personnel when global positioning system activities are required.
Financial Manager	Harry Lukowski	Works with the Tetra Tech project manager in planning related to the TDD budget and completion date; enters financial information for the project into the Tetra Tech management information system; prepares regular and special reports to assist the Tetra Tech project manager.
Quality Assurance Manager	Therese Gioia	Responsible for all quality assurance/quality control aspects of the START contract.

Notes:

EPA = U.S. Environmental Protection Agency

OSC = On-Scene Coordinator

START = Superfund Technical Assessment and Response Team

TDD = Technical Direction Document

Tetra Tech = Tetra Tech, Inc.

The Tetra Tech technical or field support personnel working on the project may vary depending on the specific needs of the project, as well as on-site conditions and staff availability. All specific training requirements for personnel will be addressed in the health and safety plan (HASP). EPA reserves the right to conduct oversight of sampling activities.

8.0 DELIVERABLES

Information and data obtained during the sampling event will be compiled in a site investigation report. The site investigation report will summarize all site activities completed during the sampling event, including data collection methods, sampling locations, analytical data results, data summary tables, and figures.

9.0 SCHEDULE

Tetra Tech estimates that the field activities summarized in this SAP will be implemented in October 2014. The projected project schedule is as follows:

- October 1, 2014 Develop HASP
- October 1, 2014 Submit Draft SAP
- October 10, 2014 Submit Final SAP
- Week of October 20, 2014 Mobilize to site and conduct sampling activities
- Submit Draft Site Investigation Report Three weeks after final validated data are received from the last laboratory
- Submit Final Site Investigation Report Two weeks after technical review comments are received from EPA

10.0 REFERENCES

1. Tetra Tech Inc. (Tetra Tech), Superfund Technical Assessment and Response Team (START IV), EPA Region 5, Contract No. EP-S5-EP-01, Quality Assurance Project Plan (QAPP), April 2014.
2. Weston Solutions, Inc. (Weston), Technical Memorandum, Analytical and Hydrogeological Evaluation, West Vermont Street Contamination Site, January 2013.
3. Weston, Technical Memorandum, Analytical and Hydrogeological Evaluation, West Vermont Street Contamination Site, March 2011.
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13. Tetra Tech. General Equipment Decontamination, SOP No. 002-3. June 2009.
14. EPA. Management of Investigation-Derived Wastes during Site Inspection, EPA/540/G-91/009, May 1991. Accessed on-line at: <http://www.epa.gov/superfund/policy/remedy/pdfs/93-45303fs-s.pdf>.

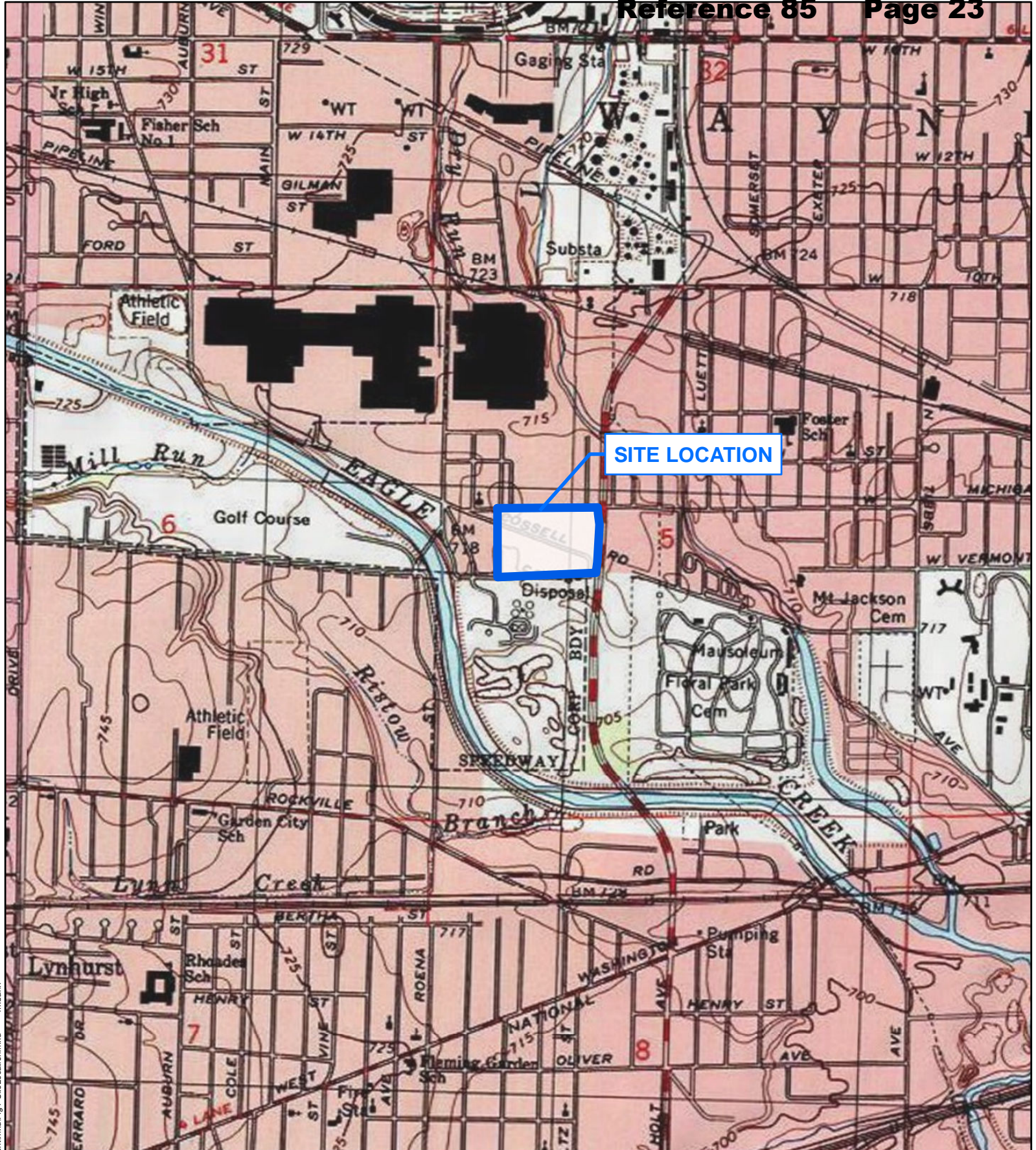
APPENDIX A - Figures

Figure 1 – Site Location Map

Figure 2 – Site Layout Map

Figure 3 – Sample Locations

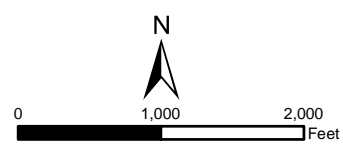
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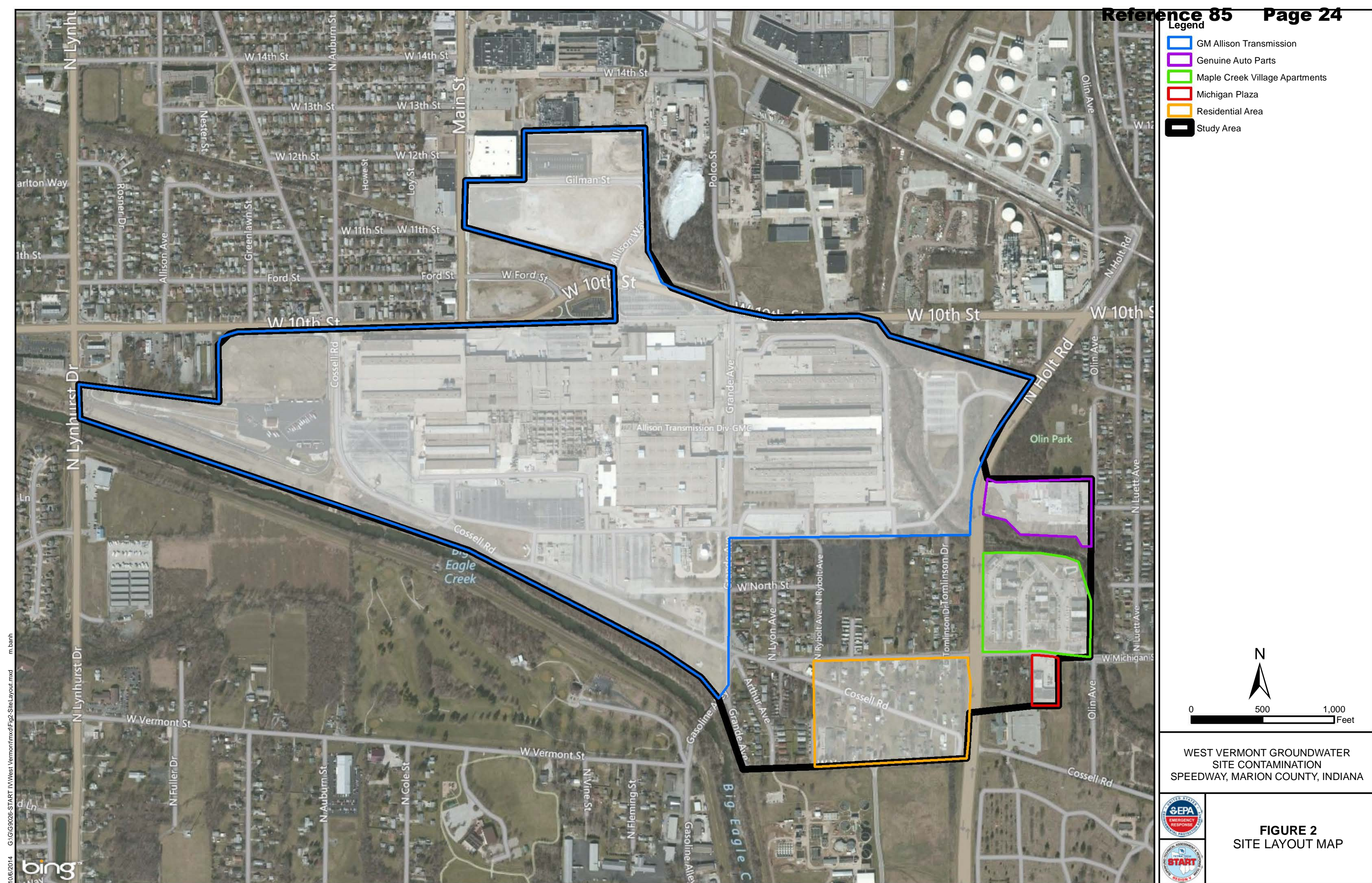


WEST VERMONT GROUNDWATER
SITE CONTAMINATION
SPEEDWAY, MARION COUNTY, INDIANA



FIGURE 1
SITE LOCATION MAP







APPENDIX B - Tables

Table 1 – Sampling Types, Analyses, Locations, and Rationale

Table 2 – Quality Assurance/Quality Control Samples

Table 3 – Analytical Methods

Table 4 – Sampling Requirements Worksheet

(12 Pages)

TABLE 1
WEST VERMONT GROUNDWATER CONTAMINATION
SAMPLING TYPES, ANALYSES, LOCATIONS, AND RATIONALE

Sample ID	Sample Type	Analysis	Location	Rationale
Groundwater				
WV-MW-1A-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-01a, east side of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-1B-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-01b, east side of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-1C-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-01c, east side of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-2A-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-02a, north of MW-WES-01 well cluster	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-2B-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-02b, north of MW-WES-01 well cluster	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-2C-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-02c, north of MW-WES-01 well cluster	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-3A-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-03a, south side of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-3B-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-03b, south side of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-4A-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-04a, north side of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-4B-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-04b, north side of residential area	Background for comparison
		Methane, Ethane, Ethene		
WV-MW-5A-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-05a, north of NE corner of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-5B-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-05b, north of NE corner of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-5C-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-05c, north of NE corner of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-6A-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-06S, east of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-6B-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-06D, east of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-7A-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-07, along Cossell Road inside residential area boundary	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-8A-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-08S, east of NE corner of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-8B-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-08D, east of NE corner of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-9A-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-09S, east of NE corner of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		
WV-MW-9B-GW	Grab	TCL VOCs	Existing USEPA monitoring well MW-WES-09D, east of NE corner of residential area	Determine the presence or absence of site-related hazardous substances
		Methane, Ethane, Ethene		

TABLE 1
WEST VERMONT GROUNDWATER CONTAMINATION
SAMPLING TYPES, ANALYSES, LOCATIONS, AND RATIONALE

Sample ID	Sample Type	Analysis	Location	Rationale
WV-MW-10-GW	Grab	TCL VOCs	Existing Allison Transmission monitoring well MW-1003-S3, north of NW corner of residential area	Background for comparison
		Methane, Ethane, Ethene		
WV-MW-11-GW	Grab	TCL VOCs	Existing Allison Transmission monitoring well MW-1105-S3/4, north of residential area	Background for comparison
		Methane, Ethane, Ethene		
WV-MW-12-GW	Grab	TCL VOCs	Existing Genuine Parts monitoring well MW-135	Background for comparison
		Methane, Ethane, Ethene		
WV-MW-13-GW	Grab	TCL VOCs	Existing Genuine Parts monitoring well MW-154	Background for comparison
		Methane, Ethane, Ethene		
WV-MW-14-GW	Grab	TCL VOCs	Existing Michigan Plaza monitoring well MMW-P-10D, northeast portion of Michigan Plaza.	Source area well
		Methane, Ethane, Ethene		
WV-MW-15-GW	Grab	TCL VOCs	Existing Michigan Plaza monitoring well MMW-P-06	Source area well
		Methane, Ethane, Ethene		
WV-MW-16-GW	Grab	TCL VOCs	Existing Genuine Parts monitoring well MW-10-1R, eastern source area	Source area well
		Methane, Ethane, Ethene		
WV-MW-17-GW	Grab	TCL VOCs	Existing Genuine Parts monitoring well MMW-148R, western source area	Source area well
		Methane, Ethane, Ethene		
WV-MW-18-GW-DUP	Grab	TCL VOCs	TBD	
		Methane, Ethane, Ethene		
WV-MW-19-GW-DUP	Grab	TCL VOCs	TBD	
		Methane, Ethane, Ethene		
WV-MW-20-GW-DUP	Grab	TCL VOCs	TBD	
		Methane, Ethane, Ethene		
Drinking Water				
WV-RES-4018WVS	Grab	TCL VOCs	West Vermont Street	Target well
		Methane, Ethane, Ethene		
WV-RES-4012COS	Grab	TCL VOCs	Cossell Road	Target well
		Methane, Ethane, Ethene		
WV-RES-XXABC	Grab	TCL VOCs	TBD	Background for comparison
		Methane, Ethane, Ethene		
WV-RES-XXABC	Grab	TCL VOCs	TBD	Background for comparison; the sample from this well is from a residential drinking water well that is screened within the same zone as the target wells.
		Methane, Ethane, Ethene		
WV-RES-XXABC-DUP	Grab	TCL VOCs		
		Methane, Ethane, Ethene		
Investigation-Derived Waste				
WV-AQ-01	Composite	TCL VOCs	Water generated during well development and sampling, and decontamination of equipment	Determine the appropriate disposal method

TABLE 1
WEST VERMONT GROUNDWATER CONTAMINATION
SAMPLING TYPES, ANALYSES, LOCATIONS, AND RATIONALE

Notes:

AQ	Aqueous
DUP	Duplicate
DW	Drinking water well
EPA	Environmental Protection Agency
GW	Groundwater
ID	Identification
MW	Monitoring well
TBD	To be determined
TCL	Target Compound List
VOC	Volatile organic compound
WV	West Vermont

TABLE 2
WEST VERMONT GROUNDWATER CONTAMINATION
QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Sample ID	Sample Type	Analytical Parameter	Container	Rationale
WV-TB-##	Trip blank (aqueous)	TCL VOCs	Three 40-mL vials with HCl	Evaluate if unknown site conditions or sample handling procedures are influencing analytical results. One trip blank will be submitted with each sample shipment for VOC analysis only.
WV-EB-##	Equipment rinsate blank (aqueous)	TCL VOCs	Three 40-mL vials with HCl	Evaluate whether decontamination procedures adequately clean sampling equipment. One equipment rinsate blank will be submitted for each type of equipment used.
		Methane, Ethane, Ethene	Three 40-mL vials	
WV-FB-##	Field blank (aqueous)	TCL VOCs	Three 40-mL vials with HCl	Evaluate the potential for contamination of a sample from sources not associated with sample collection (ambient conditions). One field blank will be submitted for each lot of high-purity, final rinse water used.
		Methane, Ethane, Ethene	Three 40-mL vials	
WV-XX-##	MS/MSD	TBD	TBD	Provide information about the effect of each sample matrix on sample preparation and analysis. One MS/MSD sample will be designated for every 20 samples collected per matrix.
WV-XX-##-DUP	Field duplicate sample	TBD	TBD	Measure both field and laboratory precision. One field duplicate sample will be collected for every 10 samples collected per matrix.

Notes:

##	Sample number to be determined in the field
DUP	Field duplicate sample
EB	Equipment rinsate blank
FB	Field blank
HCl	Hydrochloric acid
ID	Identification
mL	Milliliter
MS/MSD	Matrix spike/matrix spike duplicate
TB	Trip blank
TBD	To be determined
TCL	Target Compound List
VOC	Volatile organic compound
WV	West Vermont GW Contamination Site
XX	Sample depth to be determined in the field

TABLE 3
WEST VERMONT GROUNDWATER
ANALYTICAL METHODS

Matrix	Parameter	Concentration Level ^a	Analytical Method	Volumes and Containers	Preservation	Holding Time ^b
Aqueous	TCL VOCs	Trace, Low	SOM01.2	Three 40-mL glass vials with Teflon-lined septum	To pH < 2 with hydrochloric acid; store at 4 °C	14 days
Aqueous	Methane, Ethane, Ethene	<0.01%	RSK 175	Three 40-mL glass vials with Teflon-lined septum	Cool to 4 °C	14 days

TABLE 3
WEST VERMONT GROUNDWATER
ANALYTICAL METHODS

Notes:

^a	See START QAPP Worksheet #15 for reporting limits
^b	Holding time is measured from the time of sample collection to the time of sample extraction and analysis
<	Less than
°C	Degrees Celsius
EPA	U.S. Environmental Protection Agency
mL	Milliliter
NA	Not applicable
QAPP	Quality Assurance Project Plan
START	Superfund Technical Assessment and Response Team
TBD	To be determined
TCL	Target Compound List
VOC	Volatile organic compound

TABLE 4
WEST VERMONT GROUNDWATER CONTAMINATION
SAMPLING REQUIREMENTS WORKSHEET

Matrix ^a	Parameter ^a	Number of Investigative Samples	Number of Quality Control (QC) Samples ^b						Total Number of Investigative and QC Samples
			Matrix Spike (MS)	Matrix Spike Duplicate (MSD)	Field Duplicate	Equipment Blank	Field Blank	Trip Blank	
Groundwater	TCL VOCs, dissolved gases	28	2	2	3	1	1	1	34
Drinking Water	TCL VOCs, dissolved gases	4	1	1	1	0	0	1	6
IDW	TCL VOCs	1	0	0	0	0	0	1	2

Notes:

^a Refer to Table 2 for required sample volumes, containers, preservation techniques, and holding times.

^b Refer to Section 2.5.1 (Field Quality Control Requirements) of the Tetra Tech, Inc. START Region 5 Quality Assurance Project Plan (QAPP) for typical QC sample types and frequencies.

IDW Investigation-derived waste VOC Volatile organic compound

TCL Target Compound List

ATTACHMENT 1

TETRA TECH, INC. STANDARD OPERATING PROCEDURES

No. 015-1, Groundwater Sample Collection Using Low-Flow Sampling Methodology

SOP No. 061-2, Field Measurement of Groundwater Indicator Parameters

SOP No. 88-1, Field Measurement of Water Turbidity

SOP 014-1, Static Water Level, Total Well Depth, and Immiscible Layer Measurement

SOP No. 019-6, Packaging and Shipping Samples

SOP No. 024-1, Recording of Notes in Field Logbook

SOP No. 002-3, General Equipment Decontamination

(136 Pages)

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

**GROUNDWATER SAMPLE COLLECTION
USING LOW-FLOW SAMPLING METHODOLOGY**

SOP NO. 015

REVISION NO. 1

Last Reviewed: April 2010

K. Riesing

Quality Assurance Approved

July 28, 2009

Date

1.0 BACKGROUND

Groundwater sample collection is an integral part of site characterization at many contaminant release investigation sites. Often, a requirement of groundwater contaminant investigation is to evaluate contaminant concentrations in the aquifer. Since data quality objectives of most investigations require a laboratory setting for chemical analysis, samples must be collected from the aquifer and submitted to a laboratory for analysis. Therefore, sample collection and handling must be conducted in a manner that minimizes alteration of chemical characteristics of the groundwater.

In the past, most sample collection techniques followed federal and state guidance that included removal of water in the casing of a monitoring well (purging), followed by sample collection. The water in the casing was removed so that groundwater from the formation could flow into the casing and be available for sample collection. Sample collection was commonly completed with a bailer, bladder pump, controlled flow impeller pump, or peristaltic pump. Samples were preserved during collection. Often, samples to be analyzed for metals were filtered through a 0.45-micron filter prior to preservation and placement into the sample container.

Research conducted by several investigators has demonstrated that movement of contaminants while sorbed onto colloid particles constitutes a significant component of contaminant transport. Colloid mobility in an aquifer is a complex, aquifer-specific transport issue, and its description is beyond the scope of this standard operating procedure (SOP). However, concentrations of suspended colloids have been measured during steady-state conditions and during purging activities. Investigation results indicate standard purging procedures may cause a significant increase in suspended colloids, which in turn may bias analytical results.

Low-flow sample collection, sometimes referred to as micropurge, low-stress, or minimal drawdown groundwater sample collection, is a groundwater sampling method that minimizes increased colloid mobilization by removing water from a well at the screened interval at a rate that preserves or minimally disrupts steady-state flow conditions in the aquifer. During low-flow sampling, groundwater is discharged from the aquifer at a rate that the aquifer will yield without creating a cone of depression around the sampled well (i.e., a rate of discharge less than or equal to the rate of recharge). Research indicates that colloid mobilization will not increase above steady-state conditions during low-flow

discharge. Therefore, the sample collected by this method is more likely to represent steady-state groundwater chemistry.

1.1 PURPOSE

The purpose of this SOP is to describe the procedures to be used to collect a groundwater sample from a well using low-flow sampling methodology. The following sections describe the equipment to be used and the methods to be followed to promote uniform sample collection techniques. Sampling is to be conducted by field personnel who are experienced in sample collection and handling for environmental investigations.

1.2 SCOPE

This SOP applies to groundwater sampling using low-flow sampling methodology. It is intended to be used as an alternate SOP to SOP No. 010 (Groundwater Sampling), which provides guidance for the general aspects of groundwater sampling. This SOP provides procedures to be used for various methods of low-flow sample collection. The specific type of sampling pump to be used should be specified in the project-specific work plan or field sampling plan.

1.3 DEFINITIONS

Colloid: Suspended particles that range in diameter from 5 nanometers to 0.2 micrometers.

Dissolved oxygen: The ratio of the concentration or mass of oxygen in water relative to the partial pressure of gaseous oxygen above the liquid, which is a function of temperature, pressure, and the concentration of other solutes.

Flow-through cell: A device connected to the discharge line of a groundwater purge pump that allows regular or continuous measurement of selected parameters of the water and minimizes contact between the water and air.

pH: The negative base-10 log of the hydrogen-ion activity in moles per liter.

Reduction and oxidation potential: A numerical index of the intensity of oxidizing or reducing conditions within a system, with the hydrogen-electrode potential serving as a reference point of zero volts.

Specific conductance: The reciprocal of the resistance in ohms measured between opposite faces of a centimeter cube of aqueous solution at a specified temperature.

Turbidity: A measurement of the suspended particles in a liquid that have the ability to reflect or refract part of the visible portion of the light spectrum.

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA), Office of Research and Development. April 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. Publication: EPA/540/S-95/504. <http://www.epa.gov/ahaazvuc/download/issue/lwflw2a.pdf>

EPA, Office of Solid Waste and Emergency Response. May 2002. *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*. Publication: EPA542-S-02-001. http://www.epa.gov/tio/tsp/download/gw_sampling_guide.pdf

1.5 REQUIREMENTS AND RESOURCES

The following equipment is required to complete low-flow groundwater sample collection:

- Water level indicator
- Adjustable flow rate pump (bladder, piston, peristaltic, or impeller)
- Power source for the pump (such as a battery or generator, or compressed air source)
- Discharge flow controller
- Flow-through cell
- pH probe
- Dissolved oxygen (DO) probe
- Turbidity meter
- Oxidation and reduction (Redox or Eh) probe

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- Specific conductance (SC) probe (optional)
- Temperature probe (optional)
- Meter to display data for the probes
- Calibration solutions for pH, SC, turbidity, and DO probes, as necessary
- Container of known volume for flow measurement or calibrated flow meter
- Data recording and management system

2.0 PROCEDURE

The following procedures and criteria are based on EPA guidance titled *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures* (1996) and *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers* (2002). These references may be consulted for a more detailed description of low-flow sampling theory.

Low-flow groundwater sampling is most commonly accomplished with low discharge-rate pumps, such as bladder pumps, piston pumps, controlled velocity impeller pumps, or peristaltic pumps. Bailers and high-capacity submersible pumps are not considered acceptable low-flow sample collection devices. The purged water is monitored (in a flow-through cell or other constituent monitoring device) for chemical and optical parameters that indicate steady-state flow conditions between the sample extraction point and the aquifer. Samples are collected when steady-state conditions are indicated.

Groundwater discharge equipment may be permanently installed in the monitoring well as a dedicated system, or it can be installed in each well as needed. Most investigators agree that dedicated systems will provide the best opportunity for collecting samples most representative of steady-state aquifer conditions, but the scope and budget of a particular investigation will dictate equipment selection.

2.1 EQUIPMENT CALIBRATION

Prior to sample collection, the monitoring equipment used to measure pH, Eh, DO, turbidity, and SC should be calibrated or checked according to manufacturers' directions (see SOP No. 061 for more details regarding measurement of groundwater indicator parameters). Typically, calibration activities are completed at the field office at the beginning of sampling activities each day. The pH meter calibration

should bracket the pH range of the wells to be sampled (acidic to neutral pH range [4.00 to 7.00] or neutral to basic pH range [7.00 to 10.00]). The DO meter should be calibrated to one point (air-saturated water) or two points (air-saturated water and water devoid of all oxygen).

The SC meter and turbidity meter cannot be calibrated in the field; they are checked against a known standard. The offset of the measured value of the calibration standard can be used as a correction value. Similarly, the Eh probe cannot be calibrated in the field, but is checked against a known standard, such as Zobell solution. The instrument should display a millivolt (mv) value that falls within the range set by the manufacturer. Because Eh is temperature dependent, the measured value should be corrected for site-specific variance from standard temperature (25 °C). The Eh probe should be replaced if the reading is not within the manufacturer's specified range. All calibration data should be recorded on the Low-Flow Groundwater Sampling Data Sheet (example included as Figure 1), on a personal digital assistant (PDA), or in a logbook.

2.2 WELL PURGING

The well to be sampled should be opened, and groundwater in the well allowed to equilibrate to atmospheric pressure. Equilibration should be determined by measuring depth to water below the marked reference on the wellhead (typically the top of the well casing) over two or more 5-minute intervals. Equilibrium conditions exist when the measured depth to water varies by less than 0.01 foot over two consecutive readings. Total depth of well measurement should be made following sample collection, unless the datum is required to place nondedicated sample collection equipment. Depth to water and total well depth measurements should be made in accordance with procedures outlined in SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement).

If the well does not have a dedicated sample collection device, a new or previously decontaminated portable sample collection device should be placed within the well. If nondedicated sampling equipment is used, the least contaminated wells should be purged and sampled first and most contaminated wells should be purged and sampled last (if past sampling data are available to make this determination). The intake of the device should be positioned at the midpoint of the well screen interval. The device should be installed slowly to minimize turbulence within the water in the casing and minimize mixing of stagnant water above the screened interval with water in the screened interval. Following installation, the flow controller should be connected to the sample collection device, and the flow-through cell connected

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to the outlet of the sample collection device. The calibrated groundwater chemistry monitoring probes should be installed in the flow-through cell. If a flow meter is used, it should be installed ahead of the flow-through cell.

If the well has a dedicated sample collection device, the controller for the sample collection device should be connected to the sample collection device. The flow meter and flow-through cell should be connected in line to the discharge tube, and the probes installed in the flow-through cell. Hook-up to the appropriate power source should be the last step prior to activating the pump to ensure all connections are completed prior to starting the pump.

The controller should be activated and groundwater extracted (purged) from the well. The purge rate should be monitored, and should not exceed the capacity of the well. The well capacity is defined as the maximum discharge rate that can be obtained with less than 0.1 meter (0.33 foot) drawdown. Typically, the discharge rate will be less than 0.5 liters per minute (L/min) (0.13 gallons per minute). The maximum purge rate should not exceed 1 L/min (0.25 gallons per minute), and should be adjusted to achieve minimal drawdown.

Water levels, effluent chemistry, and effluent flow rate should be continuously monitored while purging the well. Purging should continue until the measured chemical and optical parameters are stable. Stable parameters are defined as monitored chemistry values that do not fluctuate by more than the following ranges over three successive readings at 3- to 5-minute intervals:

- pH ± 0.1 unit
- Temperature (while listed in EPA guidance, this parameter is described as the least important and not required to be stable if all other parameters have been met)
- SC ± 3 percent
- Turbidity ± 10 percent, when greater than 10 nephelometric turbidity units (NTU)
- DO ± 10 percent or 0.3 milligrams per liter (mg/L)
- Eh ± 10 mv

Purging will continue until these stabilization criteria have been met, excluding temperature, or three well casing volumes have been purged. If three casing volumes of water have been purged and the

stabilization criteria have not been met, a comment should be made on the data sheet that sample collection began after three well casing volumes were purged.

The volume of water in the well is based on the following formula:

$$V = \pi r^2 h \times 7.48$$

where

- V = static volume of water in the well (gallons)
- r = inside radius of the well (feet)
- h = length of water in the well (total well depth minus depth to water) (feet)
- 7.48 = conversion factor (cubic feet to gallons)

Common well diameter sizes and corresponding volumes are listed below.

- 1-inch well = $h \times 0.041$ gal/ft
- 2-inch well = $h \times 0.163$ gal/ft
- 3-inch well = $h \times 0.367$ gal/ft
- 4-inch well = $h \times 0.652$ gal/ft

For wells with water table screen intervals: If a stabilized drawdown in the well cannot be maintained within 0.33 feet or the water level is approaching the bottom of the screened interval, reduce the flow rate, or turn the pump off for 15 minutes, and allow for recovery. The well should not be pumped dry.

Resume pumping at a lower flow rate; if the water draws down to the bottom of the screened interval again, turn pump off and allow for recovery. If sufficient yield cannot be obtained, consider an alternative sampling method.

For wells with submerged or targeted screen intervals: If a stabilized drawdown in the well cannot be maintained within 0.33 feet or the water level is approaching the top of the screened interval, reduce the flow rate, or turn the pump off for 15 minutes, and allow for recovery. The well should not be pumped dry. Resume pumping at a lower flow rate; if the water draws down to the top of the screened interval again, turn pump off and allow for recovery. If sufficient yield cannot be obtained, consider either further drawdown or an alternative sampling method.

If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging, then sampling can proceed next time the pump is turned on. This information should be noted in the field notebook or groundwater sampling log. Slow-recovering wells should be identified and purged at the beginning of the workday to maximize field work efficiency. If possible, samples should be collected from these wells within the same workday and no later than 24 hours after the end of purging.

The final pH, SC, Eh, turbidity, and DO values should be recorded. All data should be recorded on the Low-Flow Groundwater Sampling Data Sheet (Figure 1), a PDA, or in a logbook.

2.3 SAMPLE COLLECTION

Following purging, the flow-through cell shall be disconnected, and groundwater samples should be collected directly from the discharge line. Discharge rates should be adjusted so that groundwater is dispensed into the sample container with minimal aeration of the sample. Samples collected for volatile organic compound analysis should be dispensed into the sample container at a flow rate equal to or less than 100 milliliters per minute. Samples should be preserved and handled as described in the investigation field sampling plan or quality assurance project plan. Depending on the project-specific types of analyses required, the preferred order of sample collection is as follows:

1. Volatile organic compounds (VOC)
2. Purgeable organic halogens (POX)
3. Total organic halogens (TOX)
4. Cyanide
5. Extractable organics
6. Purgeable organic carbon (POC)
7. Total metals
8. Dissolved metals
9. Total organic carbon (TOC)
10. Phenols
11. Sulfate and chloride

Title: **Groundwater Sample Collection Using
 Low-Flow Sampling Methodology**

Revision No. 1, July 2009
Last Reviewed: April 2010

12. Nitrate and ammonia

13. Radionuclides

See SOP No. 010 (Groundwater Sampling) for more information on groundwater sample collection.

Title: **Groundwater Sample Collection Using
Low-Flow Sampling Methodology**

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FIGURE 1 - LOW-FLOW GROUNDWATER SAMPLING DATA SHEET

Date/Time of Sample Collection: _____ / _____ Project Site/Subsite: _____
 Sample ID: _____
 Field ID: _____ Point Name: _____
 Depth to Well Bottom: _____ ft. below top of casing (PVC cap)
 Depth to Water Level: _____ ft. below PVC cap
 Depth to Water Level: _____ ft. below PVC cap prior to
 sampling
 Method of Purging: Bladder Pump _____ Submersible Pump _____
 Peristaltic Pump _____
 Minimum Purge Volume: 2-inch well _____ Liters / 4-inch well _____ Liters
 Control Box Settings: Box # _____ Refill _____ Discharge _____
 Throttle _____ psi
 Total Purged: _____ Liters (Purge Rate goal = 0.5 Liters/Min.)
 Actual Purge Rate: _____ Liters/Min.

Purge Calculations

PHYSIO-CHEMICAL PARAMETERS DURING PURGING											
Measure in order listed**	Initial Reading									Stabilization Criteria	Final
Time											
pH										+/-0.1	
Temperature (°C)										NC*	
Specific Conductance (µmhos/cm)										+/-3%	
Turbidity (NTU)										+/-10%	
Dissolved Oxygen (mg/L)										+/-10% or +/-0.3	
ORP (mV)										+/-10	
Each Volume Purged (L)											
Total Liters Purged											

*NC = No Criteria. **Stabilization criteria listed should be used unless project-specific plans specify alternate stabilization criteria.

Duplicate Sample Collected? No Yes (Sample ID of Duplicate) _____
 MS/MSD Sample Collected? No Yes _____
 Sample Remarks (odors, colors, sediment): _____
 Comments: _____
 Sample(s) Collected By: _____
 Pump System Purge Volume Calc: Length of tubing X 9.6 (ml/ft) + 130 (bladder volume) = Total
 required purge (liters) before collection of parameters

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

**FIELD MEASUREMENT OF GROUNDWATER
INDICATOR PARAMETERS**

SOP NO. 061

REVISION NO. 2

Last Reviewed: July 2009



Quality Assurance Approved

July 2009

Date

Title: **Field Measurement of Groundwater
Indicator Parameters**

Revision No. 2, July 2009
Last Reviewed: July 2009

1.0 BACKGROUND

Various water quality monitoring systems can be used for determining groundwater indicator parameters in the field. Commonly measured field indicator parameters include pH, specific conductance, temperature, oxidation-reduction potential (ORP), dissolved oxygen (DO) and turbidity. Groundwater field measurements are typically collected in conjunction with groundwater sampling or monitoring well development (see SOPs 010, 015, and 021).

Various types of water quality systems exist including down-hole systems and flow through cells. Tetra Tech used several common water quality meters including various types of In-Situ, YSI, Hydac, and Horiba meters (see Figure 1 at the end of this SOP). The sampling team should select the type of meter or monitoring system based on site-specific conditions including data collection needs, the types of wells being sampled, and the sampling procedures used. Multiple parameter systems should be used when multiple field parameters are to be measured.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the general requirements and procedures for using various water quality monitoring systems for determining groundwater pH, specific conductance, temperature, ORP, DO and turbidity in the field.

1.2 SCOPE

This SOP applies to general procedures for calibrating and operating water quality monitoring systems in the field. The project work plan or field sampling plan should identify the types of systems to be used and the actual project-specific field parameters to be measured. For each type of water quality system, the manufacturer's manual should be consulted for specific operating instructions.

Title: **Field Measurement of Groundwater
Indicator Parameters**

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1.3 DEFINITIONS

Single Parameter System: A meter or monitoring system consisting of a single probe designed to measure a single indicator parameter.

Multiple Parameter System: A meter or monitoring system consisting of multiple probes capable of measuring multiple indicator parameters.

Open Container Measurements: Field measurements performed in an open container such as a cup, a jar, or a bucket where an air/water interface exists.

Flow-Through Chamber or Cell: A plastic cell or chamber connected to the sample pump discharge tubing so that a continuous flow of water passes across the probes. Additional tubing is used to route water from the flow-through cell to a waste container or final discharge point.

Down-Hole Monitoring System: A meter or monitoring system where probes are submerged by inserting them into the well. The probes are attached to the meter (located at the well head or ground surface) by one or more cables.

pH: A measure of the acidity or alkalinity of a solution. The pH scale ranges from 0 to 14 with strongly acidic solutions at the low end, strongly basic solutions at the high end, and “pure” or neutral water at 7. Field measurements of pH are recorded in standard units.

Specific Conductance: The ability of a solution to conduct electricity; a measure of the solution’s ionic activity and content. The higher the concentration of ionic (dissolved) constituents, the higher the conductivity. Conductivity of the same water changes substantially with temperature. Specific conductivity is generally found to be a good measure of the concentration of total dissolved solids (TDS) and salinity. Conductivity is measured by placing two electrodes (with opposite electrical charge) in the water. For a known electrical current, the voltage drop across the electrodes reveals the solution’s resistance. Since the resistance of aqueous solution changes with temperature (resistance drops with increasing temperature), the resistance is corrected to the resistance of the solution at 25 °C. Field measurements are recorded in units of microsiemens per centimeters (μS/cm).

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Temperature: The degree of hotness or coldness of the solution being measured. Field measurements are typically recorded in degrees Celsius (°C).

ORP: ORP, or redox potential, is the tendency of a chemical species to acquire electrons and be reduced. In aqueous solutions, the reduction potential is the tendency of the solution to either gain or lose electrons when new chemical species are introduced. A solution with a higher (more positive) reduction potential than the new species will have a tendency to gain electrons from the new species (to be reduced by oxidizing the new species) and a solution with a lower (more negative) reduction potential will have a tendency to lose electrons to the new species (to be oxidized by reducing the new species). Just as the transfer of hydrogen ions between chemical species determines the pH of an aqueous solution, the transfer of electrons between chemical species determines the reduction potential of an aqueous solution. Like pH, the reduction potential represents an intensity factor. It does not characterize the capacity of the system for oxidation or reduction, in much the same way that pH does not characterize the buffering capacity. Field measurements are typically recorded in millivolts (mV).

DO: Dissolved oxygen (or oxygen saturation) is a relative measure of the amount of oxygen dissolved or carried in a given medium. In aquatic environments, dissolved oxygen is a relative measure of the amount of oxygen (O₂) dissolved in the water. Field measurements are typically recorded in milligrams per liter (mg/L).

Turbidity: Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids). Fluids can contain suspended solid matter consisting of particles of many different sizes. While some suspended material will be large enough and heavy enough to settle rapidly to the bottom of the container if a liquid sample is left to stand, very small particles will settle only very slowly or not at all if the sample is regularly agitated or the particles are colloidal. These small solid particles cause the liquid to appear turbid. Field measurements are typically recorded in Nephelometric Turbidity Units (NTU).

1.4 REFERENCE

Essential Handbook of Ground-Water Sampling by Gillian Nielsen, 2007.

Tetra Tech EM Inc. July 2009. SOPs 010, 015, and 021

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Indicator Parameters**

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1.5 REQUIREMENTS AND RESOURCES

The following items are typically required to measure groundwater pH, specific conductance, temperature, ORP, DO, and turbidity using this SOP:

- Single or multiple parameter water quality measuring system
- Specific conductance calibration solutions
- Buffer solutions of pH 4, 7, and 10 for pH calibration
- Distilled or deionized water
- Rinse bottle
- 50-milliliter (mL) sample cups or beakers
- Sample tubing and connectors (specific to each type of system)
- Waste container to collect purge water
- Logbook or field data sheets

2.0 PROCEDURES

The procedures outlined in this SOP are general and may apply to various types of water quality monitoring systems to measure groundwater pH, specific conductance, temperature, ORP, DO and turbidity in the field. General procedures for testing and calibrating the monitoring systems are presented first, followed by procedures for using the instruments and making field measurements. Each particular monitoring system should be identified in the project work plan or field sampling plan and should be operated in accordance with the manufacturer's instruction manual.

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2.1 TESTING AND CALIBRATION PROCEDURES

Each field meter or monitoring system should be calibrated according to manufacturer's specifications. In general, equipment should be thoroughly cleaned then calibrated and tested before the start-up of sampling at each site. Equipment should be calibrated and tested using manufacturer provided solutions and standards. Care should be taken to rinse the probes between testing and calibration to prevent cross contaminating solutions. Solutions should be poured from the manufacturer's container into another container to prevent compromising the entire solution provided by the manufacturer. Calibration and testing of field equipment should be documented each time it is performed in field logbooks (or field data sheets, if applicable). If testing and calibration measurements are out of tolerance, the instrument must be serviced or repaired.

2.2 FIELD MEASUREMENT PROCEDURES

Each field meter or monitoring system should be operated according to manufacturer's specifications. The actual field procedures will vary depending on the type of monitoring system being used (open container systems, flow-through cell systems, or down-hole systems) and the types of field parameters being measured. In addition, most systems include a data logging option. A description of open container, flow-through cell, and down-hole measurement processes are discussed below, followed by a general procedural summary and a summary of common errors associated with field measurements of indicator parameters.

2.2.1 Open Container Measurements

Open container measurements consist of collecting groundwater and placing it in a cup or container for field measurements using a hand held system. This method of field measurements is commonly used when bailing wells, but can also be used when pumping wells. Prior to field measurements, the equipment must be cleaned and calibrated following manufacturer's specifications. Field measurements should then be made at the frequency and for the indicator parameters specified in the project work plan or field sampling plan. To make open container field measurements, samplers collect groundwater from the well and place in a cup or container large enough to adequately submerge the probe or probes, as specified in the manufacturer's operations manual. For open containers, measurements should be taken in the following order: temperature, specific conductance, pH, and turbidity. Open container systems are not recommended for low-flow sampling as flow-through systems are more appropriate. The probes and

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cup or container should be thoroughly rinsed after each field measurement and between sampling locations.

2.2.2 Flow-Through Cell Measurements

Flow-through cell systems consist of measuring groundwater parameters as a continuous flow of water passes across the probes through a cell or chamber, and is primarily used when pumping wells and using low-flow sampling procedures. Prior to field measurements, the equipment must be cleaned and calibrated following manufacturer's specifications. Field measurements should then be made at the frequency and for the indicator parameters specified in the project work plan or field sampling plan.

The flow-through cell or chamber is placed "in line" between the discharge tubing of the pump and the container used to collect purged water. The outlet from the pump must be connected to the sample chamber input. The sample chamber outlet must then be connected or routed to a waste container (or to another designated discharge point). Tubing, fittings, and adaptors are generally required and may be provided by the manufacturer. Pump discharge tubing and chamber inlets and outlets are typically 1/2 or 3/8 inch diameter.

After the cell or chamber is connected to the pump discharge tubing and waste collection container, the sensors should be inserted into the sensor mounting plate in their respective ports. Any unused sensor ports must have plugs installed to close off the sample chamber. The probe cables are then connected to the meter following manufacturer's specifications.

With the system connected, the sampler should turn on the pump according to the manufacturer's instructions and then turn on the water quality monitor. Before recording any values, the sample chamber should be full, all air should be voided, and all of the displayed values should be stable. The probes and sample chamber should be thoroughly rinsed between sampling locations.

2.2.3 Down-Hole Measurements

Down-hole measurement systems consist of inserting the probes (or a multi-parameter sensor housing) inside a well to obtain field measurements, and is primarily used when pumping wells. Prior to field measurements, the equipment must be cleaned and calibrated following manufacturer's specifications.

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Field measurements should then be made at the frequency and for the indicator parameters specified in the project work plan or field sampling plan.

The probes or sensor are attached to a hand held meter or control unit by a cable and lowered inside the well to be sampled. Limiting factors when using down-hole systems include probe or sensor diameters and available cable lengths. The probes should be thoroughly decontaminated between sampling locations...

2.2.4 General Procedures for Field Measurements of Indicator Parameters

The following section discusses general procedures that typically apply to making field measurements of indicator parameters using various types of field instruments. Each particular type of meter or monitoring system should be identified in the project work plan or field sampling plan and should be operated in accordance with the manufacturer's instruction manual.

1. Inspect the instrument and batteries prior to the field effort.
2. Check the integrity of the buffer solutions used for field calibration since frequent replacement is necessary as a result of degradation upon exposure to the atmosphere.
3. If applicable, make sure all electrolyte solutions within the electrode(s) are at proper levels and no air bubbles are present within the electrode(s).
4. Calibrate the meter and electrode(s) on a daily use basis (or as recommended) following manufacturer's instructions and record data in field logbook or on field data sheets.
5. Immerse the electrode(s) in the sample. Stabilization may take several seconds to several minutes. If the parameter values continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be occurring in the sample, or the meter or electrode may be malfunctioning. The failure of the measurements to stabilize should be clearly noted in the logbook or field data sheet. For DO, provide for sufficient flow past the membrane by gently stirring the sample. Probes without stirrers placed in wells (down-hole measurements) may be gently moved up and down to achieve the required mixing.
6. Read and record the value of each parameter being measured making sure units of measure are clearly recorded.
7. Rinse the electrode(s) with deionized water.
8. Store the electrode(s) in accordance with manufacturer's instructions

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2.2.5 Common Errors or Problems Associated With Field Measurements

The project work plan or field sampling plan should clearly identify the types of parameters to be measured, the measurement frequency, and “stabilization” requirements. It is essential to ensure that the type of monitoring system selected is compatible with the monitoring well sampling or development methods to be utilized. Some common errors to avoid are identified below:

- No, or incorrect equipment calibration
- Incorrect or expired calibration standards
- Poor equipment maintenance
- Inadequate training or unfamiliarity with equipment
- No record of units of measure and “+” or “-“ values for ORP
- Too much time taken to measure temperature sensitive parameters
- DO and ORP measured in closed systems (flow-through cell or down-hole) instead of closed cell systems

FIGURE 1

**THE HORIBA U-10 WATER QUALITY MONITORING SYSTEM
THE IN-SITU TROLL 9500 LOW-FLOW SYSTEM
THE YSI HAND HELD 556 METER**



Horiba U-10



In-Situ Troll



YSI 556

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF WATER TURBIDITY

SOP NO. 088

REVISION NO. 1

Last Reviewed: November 1999



Quality Assurance Approved

May 20, 1993

Date

1.0 BACKGROUND

Turbidity is the appearance of opaqueness or cloudiness in a liquid resulting from the presence of suspended solid matter. The measurement of turbidity offers an indirect way to evaluate the concentration of suspended solid matter. Tetra Tech EM Inc. uses a LaMotte Company Model 2008 Turbidity Meter or equivalent to measure the turbidity of aqueous samples. Typically, turbidity measurements help evaluate the effectiveness of monitoring well development procedures or well purging procedures prior to sampling.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for obtaining turbidity measurements in the field.

1.2 SCOPE

This SOP applies only to use of the LaMotte Company Model 2008 Turbidity Meter. The model 2008 operator's manual should be consulted for a more detailed description of the instrument. Equivalent instrumentation may be used if the Model 2008 is not available.

1.3 DEFINITIONS

Nephelometry: The measurement of the amount of light scattered at right angles when a beam of light is passed through a water sample. The measurement is reported in nephelometric turbidity units (NTUs).

1.4 REFERENCES

LaMotte Company. "Model 2008 Turbidity Meter Operator's Manual."

LaMotte Company. "LaMotte 2008 Turbidity Meter Trouble Shooting Guide." On-Line Address:
<http://lamotte.com/web-site/sidefram/techtips/general/2008met.htm>

1.5 REQUIREMENTS AND RESOURCES

The equipment required to obtain turbidity measurements in the field are as follows:

- LaMotte Company Model 2008 Turbidity Meter or equivalent with standard solutions
- One 40-mL volatile organics analysis (VOA) clear glass sample vial
- Lint-free absorbent wipes

2.0 PROCEDURE

The following sections describe both calibration and operation of the LaMotte Company Model 2008 Turbidity Meter (Figure 1). Specifications for the Model 2008 are summarized in Table 1.

2.1 CALIBRATION

The LaMotte Company Model 2008 Turbidity Meter is actually calibrated at the factory; however, two standard solutions are supplied with the instrument to check the calibration of the meter in the field. To check the calibrations the standard solution closest to the anticipated sample reading is placed in the meter. The standardize control (Figure 1) is then used to adjust the meter so the display reads the known value of the standard selected. Standardizing the meter is typically completed before a series of measurements to assure the accuracy of the readings.

2.2 OPERATION

The instrument operation procedures are as follows:

1. Pour a small amount of sample into the 40-mL VOA sample vial to rinse the vial, and then discard the rinse liquid. Fill the sample vial to its neck, taking care to pour the sample gently down the side to avoid creating air bubbles.
2. Cap the sample vial and, while holding the sample vial by the cap only, wipe the outside surface of the vial with a clean, lint-free, absorbent wipe until the sample vial is dry and smudge free. Handling the sample vial only by its cap will avoid problems from

fingerprints. Set the sample vial aside on a clean surface that will not contaminate or scratch the bottom of the sample vial.

3. Select the appropriate range on the meter (0-20 NTU or 0-200 NTU).
4. Insert the sample vial into the sample chamber. Make sure the sample vial is seated on the bottom and the chamber is capped. The reading should stabilize within 15 seconds. Record the reading in the logbook and withdraw the sample vial.
5. Decontaminate the vial in accordance with SOP No. 002, "General Equipment Decontamination," between samples.

When the batteries in the turbidity meter are low, the indicator light will come on. Initially the instrument, though, will continue to function and provide accurate readings. At the end of the useful charge, readings will appear to drift. The batteries must be recharged at this point, or they may not recharge properly. The instrument can be operated while being recharged.

FIGURE 1

LAMOTTE COMPANY MODEL 2008 TURBIDITY METER

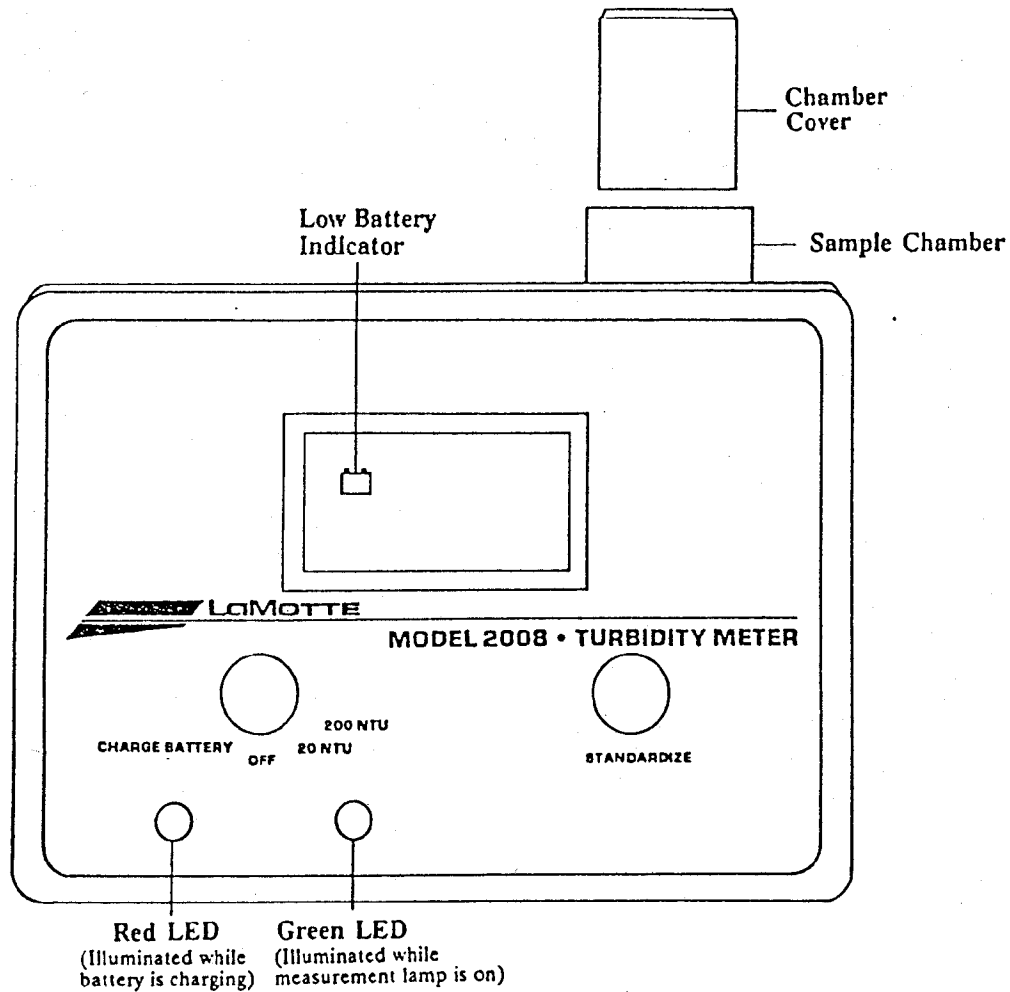


TABLE 1
SPECIFICATIONS FOR THE MODEL 2008 TURBIDITY METER

METER

Range: 0-19.99 and 0-199.9 NTU Full Scale

Measurement Accuracy: $\pm 2\%$ of reading or 0.05 NTU, whichever is greater.

Display: 0.5" Liquid Crystal Display

Warm Up Time (to specified accuracy): less than 15 seconds

PHOTOMETRIC DATA

Photodetector: Silicon photodiode, centered at 90E to the incident light path.

Lamp: Tungsten, lens-end long life, operated at a color temperature of 2230EK. Distance traversed by incident light and scattered light within the sample tube is 2.5 cm.

Lamp Life: Approximately 10,000 hours

CONTROL PANEL

Range Selector: 4-position: Charge only/Off/0-20 NTU/0-200 NTU

Standardize: For standardizing instrument with AMCO™ standards.

POWER REQUIREMENTS

Operates from internal Ni-Cad rechargeable batteries (not user replaceable)

D.C. Operation: Requires 9V, 500 ma (nominal) source - operation is possible on any D.C. source between 9 & 16 volts capable of supplying at least 300 ma.

A.C. Operation: Is possible via A.C. adapter (120 VAC input, 9V, 500 ma output)

METER HOUSING

Material: ABS

Dimensions: 7 1/2" L x 5 3/8" H x 2 3/4" W

Weight: 2.4 lbs.

OPTIONAL CARRYING CASE

Material: High Density Polyethylene Case

Dimensions: 10" L x 13 1/2" W x 6 1/8" H

Weight: 8 lbs.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

**STATIC WATER LEVEL, TOTAL WELL DEPTH,
AND IMMISCIBLE LAYER MEASUREMENT**

SOP NO. 014

REVISION NO. 1

Last Reviewed: July 2009



Quality Assurance Approved

July 2009

Date

Title: **Static Water Level, Total Well Depth, and
Immiscible Layer Measurement**

Revision No. 1, July 2009
Last Reviewed: July 2009

1.0 BACKGROUND

Measurement of static water level, total well depth, and any immiscible layers is necessary before a well can be sampled and groundwater flow direction can be determined. If an immiscible layer is present, its depth and thickness must be determined. In addition, the static water level and total depth of a monitoring well are often needed to determine a purging volume prior to sampling.

1.1 PURPOSE

This standard operating procedure (SOP) provides guidelines for field personnel measuring: (a) static water levels, (b) total water depths, and (c) immiscible layers in monitoring wells or piezometers.

1.2 SCOPE

This SOP describes the methodologies for measuring static water level, total well depth, and immiscible layer depth and thickness.

1.3 DEFINITIONS

Electrical Water Level Meter: An electrical probe used to determine the depth to fluid. The probe has a light or sound alarm connected to an open circuit. The circuit is closed and the alarm is activated when the probe contacts a conducting fluid such as water.

Immiscible Layer: A liquid phase that cannot be uniformly mixed or blended with water. Heavy immiscible phases or dense nonaqueous-phase liquids (DNAPL) sink in water; light immiscible phases or light nonaqueous-phase liquids (LNAPL) float on water.

Interface Probe: An electrical probe used to determine the presence and thicknesses of LNAPL or DNAPL in the water column of a monitoring well.

Ionization Detector: A photoionization detector (PID) or a flame ionization detector (FID) is used to measure the level of volatile organic compounds (VOC) in the gaseous phase. Ionization detectors are generally not compound-specific and thus measure only total volatile organic compounds. A PID generally cannot detect as complete a range of compounds as the FID. This difference is the result of the relative ionization energies of the two detectors. Most PIDs cannot detect methane, but FIDs can. The

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Photovac and Minirae are examples of PIDs; the Foxboro organic vapor analyzer (OVA) is an example of an FID.

Static Water Level: The level of water in a monitoring well or piezometer left open and allowed to stabilize by equilibrating to existing atmospheric pressure prior to measuring. The static water level can be measured as the depth to water or as the elevation of water relative to a reference mark or datum.

Total Well Depth: The distance from the ground surface to the bottom of a monitoring well or piezometer

1.4 REFERENCES

Tetra Tech EM Inc. 2009. SOP No. 002, General Equipment Decontamination

U.S. Environmental Protection Agency (USEPA). 2007. "Groundwater Level and Well Depth Measurement." Region 4, Field Branches Quality System and Technical Procedures. November 1. <http://www.epa.gov/region4/sesd/fbqstp/Groundwater-Level-Measurement.pdf>

U.S. EPA. 2000. "Manual Water Level Measurement." Environmental Response Team. SOP #2043 (Rev. #0.0, 02/11/00). <http://www.dem.ri.gov/pubs/sops/wmsr2043.pdf>

1.5 REQUIREMENTS AND RESOURCES

The equipment required for measuring static water levels, total well depths, and immiscible layers is as follows:

- Electrical water level meter
- Interface probe
- PID or FID
- Decontamination supplies (wash and rinse solutions, buckets, paper towels, etc.)
- Keys or wrenches for well locks and well caps
- Light source such as a flashlight or mirror to inspect inside well vaults

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- Appropriate level of personal protective equipment (PPE) as specified in the site-specific health and safety plan
- Appropriate signage and traffic control to protect personnel during monitoring activities

2.0 PROCEDURES

This section provides general guidance followed by specific procedures for measurement of static water level, total well depth, and immiscible layer.

Procedures for measuring the depth to water and the depth to the bottom of a monitoring well should be identified in the planning stage of field work. Also at this stage, measuring devices should be chosen, and an individual should be assigned to take and record measurements.

All measurement instruments should be decontaminated before and after use and between measurement locations. Refer to SOP No. 002, General Equipment Decontamination. In addition, as a general rule wells with the lowest known contaminant concentrations should be measured first followed by progressively more contaminated wells. This technique helps avoid cross-contamination from a more contaminated water source to a less contaminated water source resulting in inaccurate or false sample analytic results.

Before initiating any measuring activities, the ambient air at a monitoring well head should be monitored for possible emissions of VOCs using a PID or an FID. The site-specific health and safety plan for on-site activities should provide action levels and the rationale for selection of the appropriate ionization detector.

The sampling team should wear appropriate respiratory protection equipment when necessary. The sampling team should approach wells from the upwind side and systematically survey the inside of the well casing, the area from the casing to the ground, the area from above the well casing to the breathing zone, and the area around the well for VOCs. VOC monitoring for comparison to action levels should occur in the breathing zone(s) rather than from within the well casing. If PID or FID readings of VOCs are above action levels, the sampling team should retreat to a safe area and determine if engineering controls, increased PPE, or both are necessary to reduce exposure to VOCs above action levels listed in the site-specific health and safety plan.

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Sampling team should be careful when opening a well to check for insects or reptiles within the protective casing and use appropriate work gloves when reaching inside. The site-specific health and safety plan should be consulted for information on insects or reptiles that may be present in the project area.

2.1 STATIC WATER LEVEL MEASUREMENT

An electric water level meter is typically used to measure static water levels. The electrical probe of the meter is lowered into the monitoring well until the light or sound alarm is activated indicating the probe has touched the water surface. To ensure accuracy, the well or piezometer should be opened to allow groundwater in the well to equilibrate with atmospheric pressures before measuring depth to water. Ideally, static groundwater measurements will be collected prior to purging or sampling activities. The static water level is read directly from the graduated tape on the meter to the nearest 0.01-foot. Two to three measurements should be taken over several minutes to ensure water levels are not fluctuating. If water levels continue to fluctuate, the groundwater has not equilibrated or become static. Measurements should continue until static water levels readings are obtained before recording a final measurement. If the monitoring well top is not flush with the ground surface, the distance between the static water level and the top of the riser pipe should be measured; the height of the riser pipe above ground surface should then be subtracted from the first measurement to determine the depth to static water below ground surface. Surveyed elevations should be used if available to establish the water level elevation. The well number, measurement date and time, and individual readings should be recorded in a field logbook.

2.2 TOTAL WELL DEPTH MEASUREMENT

Total well depth can also be measured using an electric water level meter. The electrical probe of the indicator is lowered into the monitoring well until resistance is met, indicating that the probe has reached the bottom of the well. During measurement, the probe should be positioned in the well so that resistance is met, but there is no slack in the measuring tape. The total well depth is read directly from the graduated tape on the indicator to the nearest 0.01-foot. Measurements become less accurate with increased depth as the length of measuring tape deployed increases and the distance under the water column increases making it more difficult to determine if the bottom of the well has reached. In this circumstance, a weighted water level meter or measuring tape may be necessary to allow the user to “feel” the bottom of the well. Care should be taken to ensure the use of only inert and chemical-free weighted devices such as stainless steel are used. If the monitoring well top is not flush with the ground surface,

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the distance between the bottom of the well and the top of the riser pipe should be measured; the height of the riser pipe above ground surface should then be subtracted from the first measurement to determine the depth from ground surface to the bottom of the well. The well number, measurement date and time, and individual readings should be recorded in a field logbook.

2.3 IMMISCIBLE LAYER DETECTION AND MEASUREMENT

A LNAPL immiscible layer in a monitoring well can be detected by slowly lowering an interface probe to the surface of the water in the well. When the audible alarm sounds, the depth of the probe should be recorded. If the alarm is continuous, a light immiscible layer has been detected. To measure the thickness of this layer, the probe should then be slowly lowered until the alarm changes to an oscillating signal. The oscillating alarm indicates that the probe has reached a water layer. The probe depth at the time the alarm begins oscillating should be recorded as the depth to water. The thickness of the light immiscible layer should then be determined by subtracting the depth at which a continuous alarm occurred from the depth at which the alarm began to oscillate. The well number, measurement date and time, individual readings for depth and thickness, and average values for depth and thickness should be recorded in a field logbook.

To determine whether a DNAPL immiscible layer is present, the interface probe is lowered into the monitoring well and allowed to slowly drop below the water causing an oscillating alarm. If the alarm changes from an oscillating to a continuous signal, a heavier immiscible layer has been detected, and the probe depth should be recorded at that point. Total well depth obtained in Section 2.2 should be used for calculating the thickness of the DNAPL layer within the well casing. The DNAPL layer is then calculated by subtracting the depth at which the alarm became continuous from the total well depth. This procedure provides an estimate of the thickness of the DNAPL layer in the monitoring well. The well number, measurement date and time, and individual readings for depth and thickness should be recorded in a field logbook.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

PACKAGING AND SHIPPING SAMPLES

SOP NO. 019

REVISION NO. 6

December 2008



Quality Assurance Approved

December 18, 2008

Date

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1.0 BACKGROUND

In any sampling program, the integrity of a sample must be ensured from its point of collection to its final disposition. Procedures for classifying, packaging, and shipping samples are described below. Steps in the procedures should be followed to ensure sample integrity and to protect the welfare of persons involved in shipping and receiving samples. When hazardous substances and dangerous goods are sent by common carrier, their packaging, labeling, and shipping are regulated by four primary agencies that have regulatory or advisory guidelines: (1) the U.S. Department of Transportation (DOT) Hazardous Materials Regulations (HMR, *Code of Federal Regulations*, Title 49 [49 CFR] Parts 106 through 180); (2) the International Air Transportation Association (IATA) Dangerous Goods Regulations (DGR); (3) International Civil Aviation Organization (ICAO), which provides technical instructions for safe transportation of hazardous materials (dangerous goods) by air; and (4) United Nations (UN) “Recommendations of the Committee of Experts on Transport of Dangerous Goods.”

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for packaging and shipping samples. It has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) “Sampler’s Guide to the Contract Laboratory Program (CLP),” the DGR, the HMR, ICAO, and UN. Sample packaging and shipping procedures described in this SOP should be followed for all sample packaging and shipping. Deviations from the procedures in this SOP must be documented in a field logbook. This SOP assumes that samples are already collected in the appropriate sample jars and that the sample jars are labeled and tagged appropriately.

1.2 SCOPE

This SOP applies to sample classification, packaging, and shipping.

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1.3 DEFINITIONS

Custody seal: A custody seal is a tape-like seal. Placement of the custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been packaged for shipping.

Dangerous goods: Dangerous goods are articles or substances that can pose a significant risk to health, safety, or property when transported by air; they are classified as defined in Section 3 of the DGR (IATA 2008).

Environmental samples: Environmental samples include drinking water, most groundwater and ambient surface water, soil, sediment, treated municipal and industrial wastewater effluent, and biological specimens. Environmental samples typically contain low concentrations of contaminants and when handled require only limited precautionary procedures.

Hazardous Materials Regulations: The HMR are DOT regulations for the shipment of hazardous materials by air, water, and land; they are located in 49 CFR 106 through 180.

Hazardous samples: Hazardous samples include dangerous goods and hazardous substances. Hazardous samples shipped by air should be packaged and labeled in accordance with procedures specified by the DGR; ground shipments should be packaged and labeled in accordance with the HMR.

Hazardous substance: A hazardous substance is any material, including its mixtures and solutions, that is listed in Appendix A of 49 CFR 172.101 and its quantity, in one package, equals or exceeds the reportable quantity (RQ) listed in the appendix.

IATA Dangerous Goods Regulations: The DGR are regulations that govern the international transport of dangerous goods by air. The DGR are based on the International Civil Aviation Organization (ICAO) Technical Instructions. The DGR contain all of the requirements of the ICAO Technical Instructions and are more restrictive in some instances.

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Nonhazardous samples: Nonhazardous samples are those samples that do not meet the definition of a hazardous sample and **do not** need to be packaged and shipped in accordance with the DGR or HMR.

Overpack: An enclosure used by a single shipper to contain one or more packages and to form one handling unit (IATA 2008). For example, a cardboard box may be used to contain three fiberboard boxes to make handling easier and to save on shipping costs.

1.4 REFERENCES

U.S. Department of Transportation (DOT). 2007. Code of Federal Regulations, Title 49, Parts 171 through 180, especially Parts 171 (general), 172 (table, emergency response, and so on), and 173 (for shippers). Available from <http://www.access.gpo.gov/nara/cfr/cfr-table-search.html#page1>. Updated annually, late in the year or early in the following year.

DOT. 2008. "Hazardous Materials Table". (49 CFR 172.101 Table) Available on-line from <http://phmsa.dot.gov/hazmat/library>. Updated irregularly.

DOT. 2008. "Emergency Response Guidebook". Available on-line at <http://phmsa.dot.gov/hazmat/library/erg>. Updated annually.

Federal Express. 2008. "Dangerous Goods Shipping". Available on-line from <http://www.fedex.com/us/services/options/dangerousgoods/index.html>. Note especially "Declaration Forms", which can be filled out on-line or downloaded for future use, and "Resources", which includes the "Dangerous Goods Job Aid" on how to fill out the form, mark the package, and so on, the "Shipping Checklists" and the 1-800 numbers for assistance.

International Air Transport Association (IATA). 2008. "Dangerous Goods Regulations. 2009". For sale at <http://www.iata.org/ps/publications/dgr.htm>. Updated annually, with new edition available late in year.

U.S. Environmental Protection Agency. 2007. "Contract Laboratory Program Guidance for Field Samplers". EPA 540-R-07-06. Available on-line at http://www.epa.gov/superfund/programs/clp/download/sampler/clp_sampler_guidance.pdf. July.

The following additional in-house resources are also available:

Email: Contact either the TtEMI Health & Safety Director and the Regional Safety Officers at EMI.HASPAprovers or your Office Health and Safety Representative (all are included at EMI.HealthSafety).

On-line: TtEMI Intranet Page "Dangerous Goods Shipping" at <http://home.ttemi.com/C14/Dangerous%20Goods%20Shipping/default.aspx>. Includes the "Dangerous Goods Shipping Manual", various "Emergency Response Guide" excerpts, and other information, updated regularly.

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1.5 REQUIREMENTS AND RESOURCES

The procedures for packaging and shipping **nonhazardous** samples require the following:

- Coolers
- Ice
- Vermiculite, bubble wrap, or similar cushioning material
- Chain-of-custody forms and seals
- Airbills
- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)

The procedures for packaging and shipping **hazardous** samples require the following:

- Ice
- Vermiculite or other non-combustible, absorbent packing material
- Chain-of-custody forms and seals
- Appropriate dangerous goods airbills and emergency response information to attach to the airbill
- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)
- Appropriate shipping containers as specified in the DGR
- Labels that apply to the shipment such as hazard labels, address labels, “Cargo Aircraft Only” labels, and package orientation labels (up arrows)

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2.0 PROCEDURES

The following procedures apply to packaging and shipping nonhazardous and hazardous samples.

2.1 SAMPLE CLASSIFICATION

Prior to sample shipment, it must be determined whether the sample is subject to the DGR. Samples subject to these regulations shall be referred to as hazardous samples. If the hazardous sample is to be shipped by air, then the DGR should be followed. Any airline, including FedEx, belonging to IATA must follow the DGR. As a result, FedEx **may not** accept a shipment that is packaged and labeled in accordance with the HMR (although in most cases, the packaging and labeling would be the same for either set of regulations). The HMR states that a hazardous material may be transported by aircraft in accordance with the ICAO Technical Instruction (49 CFR 171.11) upon which the DGR is based. Therefore, the use of the DGR for samples to be shipped by air complies with the HMR, but not vice versa.

Most environmental samples are not hazardous samples and do not need to be packaged in accordance with any regulations. Hazardous samples are those samples that can be classified as specified in Section 3 of the DGR, can be found in the List of Dangerous Goods in the DGR in bold type, are considered a hazardous substance (see definition), or are mentioned in “Section 2 - Limitations” of the DGR for countries of transport or airlines (such as FedEx). The hazard classifications specified in the DGR (and the HMR) are as follows:

Class 1 - Explosives

- Division 1.1 - Articles and substances having a mass explosion hazard
- Division 1.2 - Articles and substances having a projection hazard but not a mass explosion hazard
- Division 1.3 - Articles and substances having a fire hazard, a minor blast hazard and/or a minor projection hazard but not a mass explosion hazard
- Division 1.4 - Articles and substances presenting no significant hazard
- Division 1.5 - Very sensitive substances mass explosion hazard
- Division 1.6 - Extremely insensitive articles which do not have a mass explosion hazard

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Class 2 - Gases

- Division 2.1 - Flammable gas
- Division 2.2 - Non-flammable, non-toxic gas
- Division 2.3 - Toxic gas

Class 3 - Flammable Liquids

Class 4 - Flammable Solids; Substances Liable to Spontaneous Combustion; Substances, which, in Contact with Water, Emit Flammable Gases

- Division 4.1 - Flammable solids
- Division 4.2 - Substances liable to spontaneous combustion
- Division 4.3 - Substances, which, in contact with water, emit flammable gases

Class 5 - Oxidizing Substances and Organic Peroxides

- Division 5.1 - Oxidizers
- Division 5.2 - Organic peroxides

Class 6 - Toxic and Infectious Substances

- Division 6.1 - Toxic substances
- Division 6.2 - Infectious substances

Class 7 - Radioactive Materials

Class 8 - Corrosives

Class 9 - Miscellaneous Dangerous Goods

The criteria for each of the first eight classes are very specific and are outlined in Section 3 of the DGR and 49 CFR 173 of the HMR. Some classes and divisions are further divided into packing groups based on their level of danger. Packing group I indicates a great danger, packing group II indicates a medium danger, and packing group III indicates a minor danger.

Class 1, explosives, includes any chemical compound, mixture, or device that by itself is capable of chemical chain reaction sufficient to produce a substantial, instantaneous release of gas, heat, and/or pressure. Tetra Tech does not ship substances that fall under this class.

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Class 2, gases, includes any compressed gas being shipped and any noncompressed gas that is either flammable or toxic. A compressed gas is defined as having a pressure over 40 pounds per square inch (psi) absolute (25 psi gauge). Most air samples and empty cylinders that did not contain a flammable or toxic gas are exempt from the regulations. An empty hydrogen cylinder, as in a flame ionization detector (FID), is considered a dangerous good unless it is properly purged with nitrogen in accordance with the HMR. A landfill gas sample is usually considered a flammable gas because it may contain a high percentage of methane.

Class 3, flammable liquids, are based on the boiling point and flash point of a substance. DOT defines flammable liquids as substances with a flash point less than 140 °F. Most class 3 samples include solvents, oil, gas, or paint-related material collected from drums, tanks, or pits.

Class 4 are flammable solids; substances liable to spontaneous combustion; and substances which, in contact with water, emit flammable gasses. Tetra Tech does not ship substances that fall under this class.

Class 5, oxidizers and organic peroxides, include substances that readily yields oxygen, which may result in the ignition of combustible materials. Organic peroxide is combustible and reacts as an oxidizer in contact with other combustible materials. By itself, an organic peroxide can be flammable or explosive. Tetra Tech does not ship substances that fall under this class.

Division 6, toxic and infectious substances, is based on oral toxicity (LD₅₀ [lethal dose that kills 50 percent of the test animals]), dermal toxicity (LD₅₀ values), and inhalation toxicity (LC₅₀ [lethal concentration that kills 50 percent of the test animals] values). Division 6.1 substances include pesticides and cyanide. Tetra Tech does not ship substances that fall under this class.

Class 7, radioactive material, is defined as any article or substance with a specific activity greater than 70 kiloBecquerels (kBq/kg) (0.002 [microCuries per gram [: Ci/g]). If the specific activity exceeds this level, the sample should be shipped in accordance with Section 10 of the DGR.

Class 8, corrosives, are based on the rate at which a substance destroys skin tissue or corrodes steel; they are not based on pH. Class 8 materials include the concentrated acids used to preserve water samples. Preserved water samples are not considered Class 8 substances and should be packaged as nonhazardous samples.

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Class 9, miscellaneous dangerous goods, are substances that present a danger but are not covered by any other hazard class. Examples of Class 9 substances include asbestos, polychlorinated biphenyls (PCB), and dry ice.

Unlike the DGR, the HMR includes combustible liquids in hazard class 3. The definition of a combustible liquid is specified in 49 CFR 173.120 of the HMR. The HMR has an additional class, ORM-D, that is not specified in the DGR. “ORM-D material” refers to a material such as a consumer commodity that, although otherwise subject to the HMR, presents a limited hazard during transport due to its form, quantity, and packaging. It must be a material for which exceptions are provided in the table of 49 CFR 172.101. The DGR lists consumer commodities as a Class 9 material.

In most instances, the hazard of a material sampled is unknown because no laboratory testing has been conducted. A determination as to the suspected hazard of the sample must be made using knowledge of the site, field observations, field tests, and other available information.

According to 40 CFR 261.4(d) and (e), samples transported to a laboratory for testing or treatability studies, including samples of hazardous wastes, are **not** hazardous wastes. FedEx will not accept a shipment of hazardous waste.

2.2 PACKAGING NONHAZARDOUS SAMPLES

Nonhazardous samples, after being appropriately containerized, labeled, and tagged, should be packaged in the following manner. Note that these are general instructions; samplers should be aware of any client-specific requirements concerning the placement of custody seals or other packaging provisions.

1. Place the sample in a resealable plastic bag.
2. Place the bagged sample in a cooler and pack it to prevent breakage.
3. Prevent breakage of bottles during shipment by either wrapping the sample container in bubble wrap, or lining the cooler (bottom and sides) with a noncombustible material such as vermiculite. Vermiculite is especially recommended because it will absorb any free liquids inside the cooler. It is recommended that the cooler be lined with a large plastic garbage bag before samples, ice, and absorbent packing material are placed in the cooler.

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4. Add a sufficient quantity of ice to the cooler to cool samples to 4 °C. Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. As an option, a temperature blank (a sample bottle filled with distilled water) can be included with the cooler.
5. Seal the completed chain-of-custody forms in a plastic bag and tape the plastic bag to the inside of the cooler lid.
6. Tape any instructions for returning the cooler to the inside of the lid.
7. Close the lid of the cooler and tape it shut by wrapping strapping tape around both ends and hinges of the cooler at least once. Tape shut any drain plugs on the cooler.
8. Place two signed custody seals on the cooler, ensuring that each one covers the cooler lid and side of the cooler. Place clear plastic tape over the custody seals.
9. Place address labels on the outside top of the cooler.
10. Ship samples overnight by a commercial carrier such as FedEx.

2.3 PACKAGING HAZARDOUS SAMPLES

The procedures for packaging hazardous samples are summarized below. Note that according to the DGR, all spellings must be exactly as they appear in the List of Dangerous Goods, and only approved abbreviations are acceptable. The corresponding HMR regulations are provided in parentheses following any DGR referrals. The HMR must be followed only if shipping hazardous samples by ground transport.

1. Determine the proper shipping name for the material to be shipped. All proper shipping names are listed in column B of the List of Dangerous Goods table in Section 4 of the DGR (or column 2 of the Hazardous Materials Table in 49 CFR 172.101). In most instances, a generic name based on the hazard class of the material is appropriate. For example, a sample of an oily liquid collected from a drum with a high photoionization detector (PID) reading should be packaged as a flammable liquid. The proper shipping name chosen for this sample would be “flammable liquid, n.o.s.” The abbreviation “n.o.s.” stands for “not otherwise specified” and is used for generic shipping names. Typically, a specific name, such as acetone, should be inserted in parentheses after most n.o.s. descriptions. However, a technical name is not required when shipping a sample for testing purposes and the components are not known. If shipping a hazardous substance (see definition), then the letters “RQ” must appear in front of the proper shipping name.
2. Determine the United Nations (UN) identification number, class or division, subsidiary risk if any, required hazard labels, packing group, and either passenger aircraft or cargo aircraft packing instructions based on the quantity of material being shipped in one

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package. This information is provided in the List of Dangerous Goods (or Hazardous Materials Table in 49 CFR 172.101) under the appropriate proper shipping name. A “Y” in front of a packing instruction indicates a limited quantity packing instruction. If shipping dry ice or a limited quantity of a material, then UN specification shipping containers do not need to be used.

3. Determine the proper packaging required for shipping the samples. Except for limited quantity shipments and dry ice, these are UN specification packages that have been tested to meet the packing group of the material being shipped. Specific testing requirements of the packages is listed in Section 6 of the DGR (or 49 CFR 178 of the HMR). All UN packages are stamped with the appropriate UN specification marking. Prior planning is required to have the appropriate packages on hand during a sampling event where hazardous samples are anticipated. Most samples can be shipped in either a 4G fiberboard box, a 1A2 steel drum, or a 1H2 plastic drum. Drums can be purchased in 5- and 20-gallon sizes and are ideal for shipping multiple hazardous samples. When FedEx is used to ship samples containing PCBs, the samples must be shipped in an inner metal packaging (paint can) inside a 1A2 outer steel drum. This method of packaging PCB samples is in accordance with FedEx variation FX-06, listed in Section 2 of the DGR.
4. Place each sample jar in a separate resealable plastic bag. Some UN specification packagings contain the sample jar and plastic bag to be used when shipping the sample.
5. Place each sealed bag inside the approved UN specification container (or other appropriate container if a limited quantity or dry ice) and pack with enough noncombustible, absorbent, cushioning material (such as vermiculite) to prevent breakage and to absorb liquid.
6. Place chain-of-custody forms in a resealable plastic bag and either attach it to the inside lid of the container or place it on top inside the container. Place instructions for returning the container to the shipper on the inside lid of the container as appropriate. Close and seal the shipping container in the manner appropriate for the type of container being used.
7. Label and mark each package appropriately. All irrelevant markings and labels need to be removed or obliterated. All outer packagings must be marked with proper shipping name; identification number; and name, address, and phone numbers of the shipper and the recipient. For carbon dioxide, solid (dry ice), the net weight of the dry ice within the package needs to be marked on the outer package. For limited quantity shipments, the words “limited quantity” or “LTD. QTY.” must be marked on the outer package. Affix the appropriate hazard label to the outer package. If the material being shipped contains a subsidiary hazard, then a subsidiary hazard label must also be affixed to the outer package. The subsidiary hazard label is identical to the primary hazard label except that the class or division number is not present. It is acceptable to obliterate the class or division marking on a primary hazard label and use it as the subsidiary hazard label. If using cargo aircraft only packing instructions, then the “Cargo Aircraft Only” label must be used. Package orientation labels (up arrows) must be placed on opposite sides of the outer package. Figure 1 depicts a properly marked and labeled package.

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8. If using an overpack (see definition), mark and label the overpack and each outer packaging within the overpack as described in step 7. In addition, the statement “INNER PACKAGES COMPLY WITH PRESCRIBED SPECIFICATIONS” must be marked on the overpack.
9. Attach custody seals, and fill out the appropriate shipping papers as described in Section 2.4.

2.4 SHIPPING PAPERS FOR HAZARDOUS SAMPLES

A “Shippers Declaration for Dangerous Goods” and “Air Waybill” must be completed for each shipment of hazardous samples. Four copies of the Shipper’s Declaration are required and it must be typed. FedEx supplies a Dangerous Goods Airbill to its customers; the airbill combines both the declaration and the waybill. An example of a completed Dangerous Goods Airbill is depicted in Figure 2. A shipper’s declaration must contain the following:

- Name and address of shipper and recipient
- Air waybill number (not applicable to the HMR)
- Page ____ of ____
- Shipper’s reference number (project number)
- Deletion of either “Passenger and Cargo Aircraft” or “Cargo Aircraft Only,” whichever does not apply
- Airport or city of departure
- Airport or city of destination
- Deletion of either “Non-Radioactive” or “Radioactive,” which ever does not apply
- The nature and quantity of dangerous goods. This includes the following information in the following order (obtained from the List of Dangerous Goods in the DGR): proper shipping name, class or division number, UN identification number, packing group number, subsidiary risk, quantity in liters or kilograms (kg), type of packaging used, packing instructions, authorizations, and additional handling information. Authorizations include the words “limited quantity” or “LTD. QTY.” if shipping a limited quantity, any special provision numbers listed in the List of Dangerous Goods in the DGR, and the variation “USG-14” when a technical name is required after the proper shipping name but not entered because it is unknown.

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- Signature for the certification statement
- Name and title of signatory
- Place and date of signing certification
- A 24-hour emergency response telephone number for use in the event of an incident involving the dangerous good
- Emergency response information attached to the shipper's declaration. This information can be in the form of a material safety data sheet or the applicable North American Emergency Response Guidebook (NAERG; DOT 1996) pages. Figure 3 depicts the appropriate NAERG emergency response information for "Flammable liquids, n.o.s." as an example.

Note that dry ice does not require an attached shipper's declaration. However, the air waybill must include the following on it: "Dry ice, 9, UN1845, ____ x ____ kg." The blanks must include the number of packages and the quantity in kg in each package. If using FedEx to ship dry ice, the air waybill includes a box specifically for dry ice. Simply check the appropriate box and enter in the number of packages and quantity in each package.

The HMR requirements for shipping papers are located in 49 CFR 172 Subpart C.

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3.0 POTENTIAL PROBLEMS

The following potential problems may occur during sample shipment:

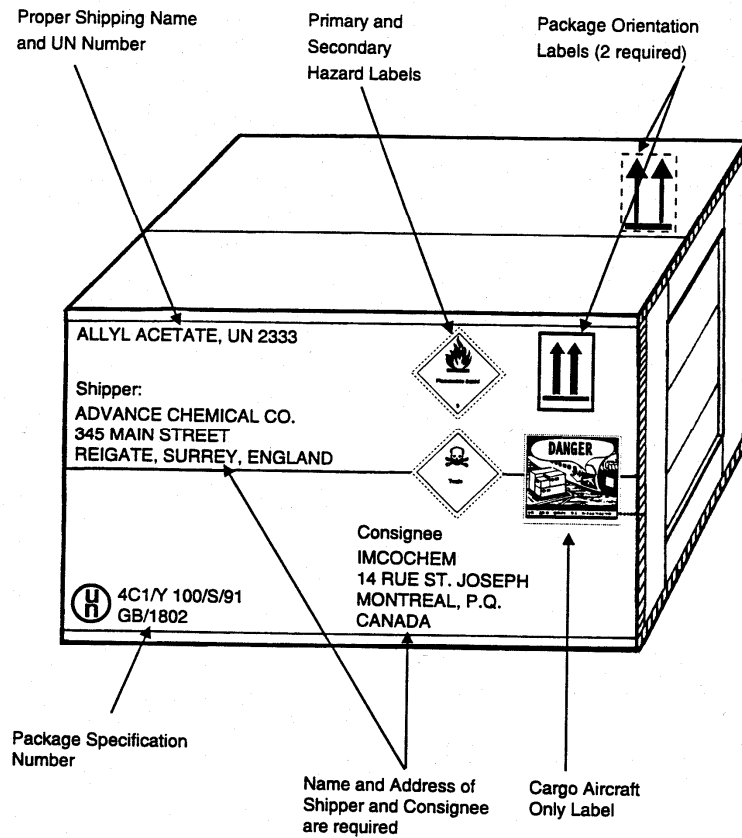
- Leaking package. If a package leaks, the carrier may open the package, return the package, and if a dangerous good, inform the Federal Aviation Administration (FAA), which can result in fines.
- Improper labeling and marking of package. If mistakes are made in labeling and marking the package, the carrier will most likely notice the mistakes and return the package to the shipper, thus delaying sample shipment.
- Improper, misspelled, or missing information on the shipper's declaration. The carrier will most likely notice this as well and return the package to the shipper.

Contact FedEx with questions about dangerous goods shipments by calling 1-800-463-3339 and asking for a dangerous goods expert.

Also contact Tetra Tech health and safety representatives using the website identified on Page 3 of this SOP.

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FIGURE 1
EXAMPLE OF A CORRECTLY MARKED AND LABELED DANGEROUS GOODS PACKAGE



Source: International Air Transport Association (IATA). 1997.

EXAMPLE OF A DANGEROUS GOODS AIRBILL

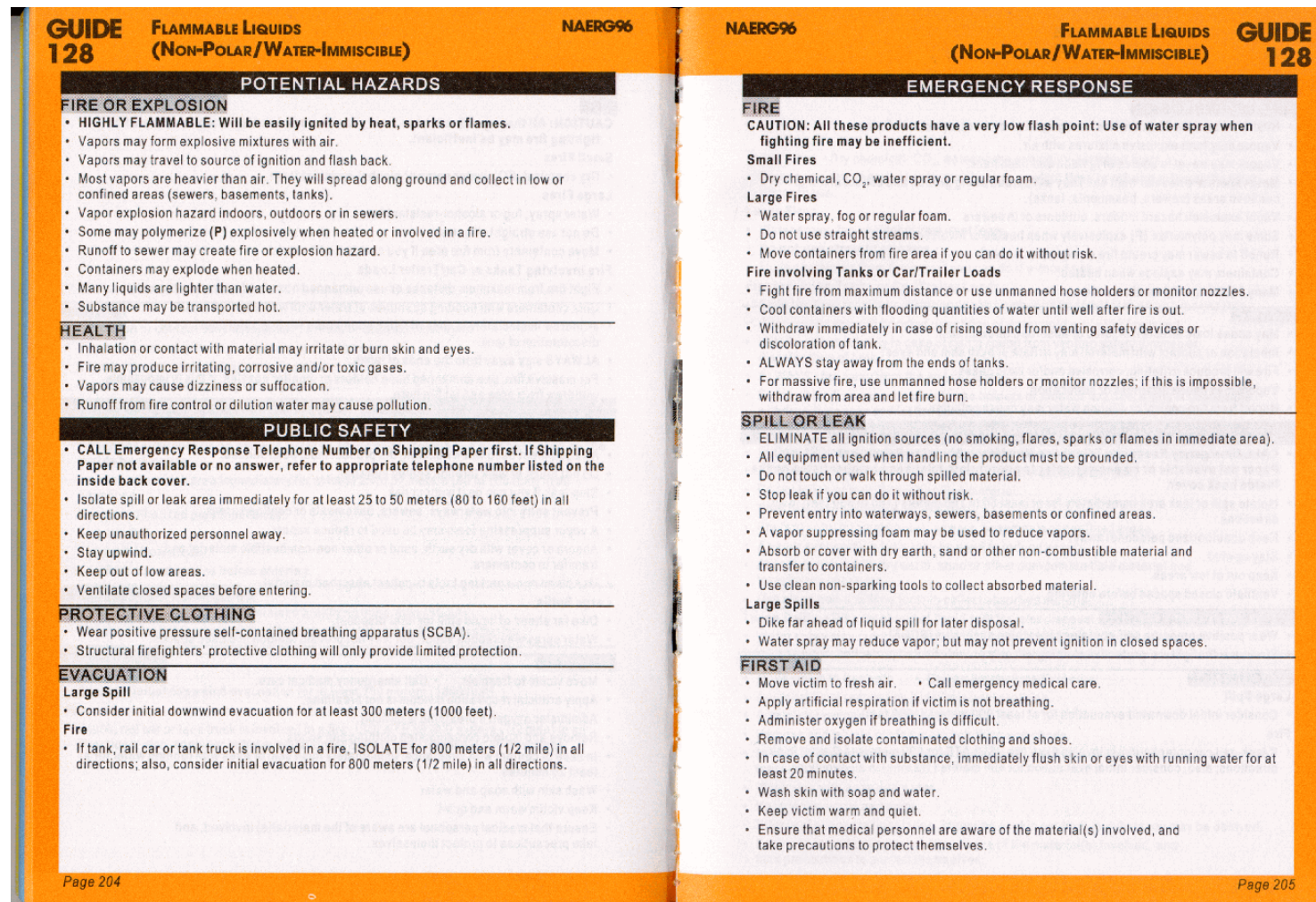
Filling Out the FedEx Dangerous Goods Airbill

- The Dangerous Goods Airbill has two sections
 - The top section of the page is the airbill portion.
 - The bottom section is the Shipper's Declaration for Dangerous Goods.
- The sender *must complete* the following fields on the pre-printed airbill:
 - Section 1: Date
 - Section 1: Sender's Name
 - Section 7: Total Packages
 - Section 7: Total Weight
- Declaration for Dangerous Goods:
 - Under the section labeled "Proper Shipping Name" fill in the infectious substance (i.e., HIV, HCV, etc.) in the parentheses.
 - Under the "Quantity and Type of Packing" section, fill in the amount of specimen in the box (in mls).
 - List an emergency telephone number in the space provided at the bottom of the airbill.
 - Sign and date the airbill in the bottom right corner.

IMPORTANT: You must follow explicitly all packaging and labeling instructions for shipping infectious substances. Correct spelling and legibility are important. Otherwise, your package will be delayed or may be rejected by FedEx.

[illegible]

FIGURE 3
NAERG EMERGENCY RESPONSE INFORMATION
FOR FLAMMABLE LIQUIDS, N.O.S.



Source: DOT and others. 1996.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

RECORDING OF NOTES IN FIELD LOGBOOK

SOP NO. 024

REVISION NO. 1
May 18, 1993

Last Reviewed: December 2008



Quality Assurance Approved

December 5, 2008

Date

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1.0 BACKGROUND

The field logbook should contain detailed records of all the field activities, interviews of people, and observations of conditions at a site. Entries should be described in as much detail as possible so that personnel can accurately reconstruct, after the fact, activities and events during their performance of field assignments. Field logbooks are considered accountable documents in enforcement proceedings and may be subject to review. Therefore, the entries in the logbook must be accurate and detailed; and they must reflect the importance of the field events.

1.1 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide guidance to ensure that logbook documentation for any field activity is correct, complete, and adequate. Logbooks are used for identifying, locating, labeling, and tracking samples. A logbook should document any deviations from the project approach, work plans, quality assurance project plans, health and safety plans, sampling plans, and any changes in project personnel. They also serve as documentation of any photographs taken during the course of the project. In addition, the data recorded in the logbook may assist in the interpretation of analytical results. A complete and accurate logbook also aids in maintaining good quality control. Quality control is enhanced by proper documentation of all observations, activities, and decisions.

1.2 SCOPE

This SOP establishes the general requirements and procedures for recording notes in the field logbook.

1.3 DEFINITIONS

None

1.4 REFERENCES

Compton, R.R. 1985. *Geology in the Field*. John Wiley and Sons. New York, N.Y.

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1.5 REQUIREMENTS AND RESOURCES

The following items are required for field notation:

- Field logbooks
- Ballpoint pens with permanent ink
- 6-inch ruler (optional)

Field logbooks should be bound (sewn) with water-resistant and acid-proof covers; they should have preprinted lines and wide columns. They should be approximately 7 1/2 by 4 1/2 inches or 8 1/2 by 11 inches in size. Loose-leaf sheets are not acceptable for field notes. If notes are written on loose paper, they must be transcribed as soon as possible into a regular field logbook by the same person who recorded the notes.

Logbooks can be obtained from an individual's office supply room or directly from outside suppliers. Logbooks must meet the requirements specified in this SOP and should include preprinted pages that are consecutively numbered. If the numbers must be written by hand, the numbers should be circled so that they are not confused with data.

2.0 PROCEDURES

The following subsections provide general guidelines and formatting requirements for field logbooks, and detailed procedures for completing field logbooks.

2.1 GENERAL GUIDELINES

- A separate field logbook must be maintained for each project. If a site consists of multiple subsites, designate a separate logbook for each subsite. For special tasks, such as periodic well water-level measurements, data from multiple subsites may be entered into one logbook that contains only one type of information.
- All logbooks must be bound and contain consecutively numbered pages.
- No pages can be removed from the logbook for any purpose.

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- All field activities, meetings, photographs, and names of personnel must be recorded in the site logbook.
- Each logbook pertaining to a site or subsite should be assigned a serial number based on the date the logbook is issued to the project manager. The first issued logbook should be assigned number 1, the next issued logbook assigned number 2, and so on. The project manager is to maintain a record of all logbooks issued under the project.
- All information must be entered with a ballpoint pen with waterproof ink. Do not use pens with “wet ink,” because the ink may wash out if the paper gets wet. Pencils are not permissible for field notes because information can be erased. The entries should be written dark enough so that the logbook can be easily photocopied.
- Do not enter information in the logbook that is not related to the project. The language used in the logbook should be factual and objective.
- Begin a new page for each day’s notes.
- Write notes on every line of the logbook. If a subject changes and an additional blank space is necessary to make the new subject title stand out, skip one line before beginning the new subject. Do not skip any pages or parts of pages unless a day’s activity ends in the middle of a page.
- Draw a diagonal line on any blank spaces of four lines or more to prevent unauthorized entries.

2.2 LOGBOOK FORMAT

The layout and organization of each field logbook should be consistent with other field logbooks. Guidelines for the cover, spine, and internal pagination are discussed below.

2.2.1 FORMAT OF FIELD LOGBOOK COVER AND SPINE

Write the following information in clear capital letters on the front cover of each logbook using a Sharpie® or similar type permanent ink marker:

- Logbook identification number
- The serial number of the logbook (assigned by the project manager)
- Name of the site, city, and state
- Name of subsite if applicable
- Type of activity

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- Beginning and ending dates of activities entered into the logbook
- “Tetra Tech EM Inc.” City and State
- “REWARD IF FOUND”

Some of the information listed above, such as the list of activities and ending dates, should be entered after the entire logbook has been filled or after decision that the remaining blank pages in the logbook will not be filled.

The spine of the logbook should contain an abbreviated version of the information on the cover: for example, “1, Col. Ave., Hastings, 5/88 - 8/88.”

2.2.2 First Page of the Field Logbook

Spaces are usually provided on the inside front cover (or the opening page in some logbooks), for the company name (“Tetra Tech EM Inc.”), address, contact name, and telephone number. If preprinted spaces for this information are not provided in the logbook, write the information on the first available page.

2.3 ENTERING INFORMATION IN THE LOGBOOK

Enter the following information at the beginning of each day or whenever warranted during the course of a day:

- Date
- Starting time
- Specific location
- General weather conditions and approximate temperature
- Names of personnel present at the site. Note the affiliation(s) and designation(s) of all personnel
- Equipment calibration and equipment models used.
- Changes in instructions or activities at the site
- Levels of personal protective clothing and equipment

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- A general title of the first task undertaken (for example, well installation at MW-11, decon at borehole BH-11, groundwater sampling at MW-11)
- Approximate scale for all diagrams. If this can't be done, write "not to scale" on the diagram. Indicate the north direction on all maps and cross-sections. Label features on each diagram.
- Corrections, if necessary, necessarily including a single line through the entry being corrected. Initial and date any corrections made in the logbook.
- After last entry on each page, initials of the person recording notes. No information is to be entered in the area following these initials.
- At the end of the day, signature of the person recording notes and date at the bottom of the last page. Indicate the end of the work day by writing "Left site at (time)." A diagonal line must be drawn across any remaining blank space at the bottom of this last page.

The following information should be recorded in the logbook after taking a photograph:

- Time, date, location, direction, and, if appropriate, weather conditions
- Description of the subject photographed and the reason for taking the picture
- Sequential number of the photograph and the film roll number or disposable camera used (if applicable)
- Name of the photographer.

The following information should be entered into the logbook when collecting samples:

- Location description
- Name(s) of sampler(s)
- Collection time
- Designation of sample as a grab or composite sample
- Type of sample (water, sediment, soil gas, etc.)
- On-site measurement data (pH, temperature, specific conductivity)
- Field observations (odors, colors, weather, etc.)
- Preliminary sample description
- Type of preservative used
- Instrument readings.

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If pre-printed field data forms are available (forms such as the micropurge field data collection form), data should be entered on these pre-printed forms rather than into field logbooks. Note in the logbook that the field data are recorded on separate forms.

2.4 PRECAUTIONS

Custody of field logbooks must be maintained at all times. Field personnel must keep the logbooks in a secure place (locked car, trailer, or field office) when the logbook is not in personal possession.

Logbooks are official project documents and must be treated as such.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GENERAL EQUIPMENT DECONTAMINATION

SOP NO. 002

REVISION NO. 3

Last Reviewed: June 2009



Quality Assurance Approved

6-19-09

Date

1.0 BACKGROUND

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

1.2 SCOPE

This SOP applies to decontaminating general nondisposable field equipment. To prevent contamination of samples, all sampling equipment must be thoroughly cleaned prior to each use.

1.3 DEFINITIONS

Alconox: Nonphosphate soap, obtained in powder detergent form and dissolved in water

Liquinox: Nonphosphate soap, obtained in liquid form for mixing with water

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992a. “Guide to Management of Investigation-Derived Wastes.” Office of Solid Waste and Emergency Response. Washington D.C. EPA 9345.3-03FS. January.

EPA. 1992b. “RCRA Ground-Water Monitoring: Draft Technical Guidance.” Office of Solid Waste. Washington, DC. EPA/530-R-93-001. November.

EPA. 1994. “Sampling Equipment Decontamination.” Environmental Response Team SOP #2006 (Rev. #0.0, 08/11/94). <http://www.ert.org/mainContent.asp?section=Products&subsection=List>

1.5 REQUIREMENTS AND RESOURCES

The equipment required to conduct decontamination is as follows:

- Scrub brushes
- Large wash tubs or buckets
- Squirt bottles
- Alconox or Liquinox
- Tap water
- Distilled water
- Plastic sheeting
- Aluminum foil
- Methanol or hexane
- Isopropanol (pesticide grade)
- Dilute (0.1 N) nitric acid

2.0 PROCEDURE

The procedures below discuss decontamination of personal protective equipment (PPE), drilling and monitoring well installation equipment, borehole soil sampling equipment, water level measurement equipment, general sampling equipment, and groundwater sampling equipment.

2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off site or to clean areas. All used disposable protective clothing, such as Tyvek coveralls, gloves, and booties, will be containerized for later disposal. Decontamination water will be containerized in 55-gallon drums (refer to Section 3.0).

Personnel decontamination procedures will be as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.

3. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.
4. Wash outer gloves in Liquinox or Alconox solution and rinse in clean water. Remove outer gloves and place into plastic bag for disposal.
5. Remove Tyvek or coveralls. Containerize Tyvek for disposal and place coveralls in plastic bag for reuse.
6. Remove air purifying respirator (APR), if used, and place the spent filters into a plastic bag for disposal. Filters should be changed daily or sooner depending on use and application. Place respirator into a separate plastic bag after cleaning and disinfecting.
7. Remove disposable gloves and place them in plastic bag for disposal.
8. Thoroughly wash hands and face in clean water and soap.

2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling equipment should be decontaminated at a designated location on site before drilling operations begin, between borings, and at completion of the project. Decontamination may be conducted on a temporary decontamination pad constructed at satellite locations within the site area in support of temporary work areas. The purpose of the decontamination pad is to contain wash waters and potentially contaminated soil generated during decontamination procedures. Decontamination pads may be constructed of concrete, wood, or plastic sheeting, depending on the site-specific needs and plans. Wash waters and contaminated soil generated during decontamination activities should be considered contaminated and thus, should be collected and containerized for proper disposal.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they should be steam cleaned and placed on polyethylene sheeting on-site prior to placement downhole. The drilling subcontractor will typically furnish the steam cleaner and water.

The drilling auger, bits, drill pipe, any portion of drill rig that is over the borehole, temporary casing, surface casing, and other equipment used in or near the borehole should be decontaminated by the drilling subcontractor as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Remove loose soil using shovels, scrapers, wire brush, etc.
4. Steam clean or pressure wash to remove all visible dirt.
5. If equipment has directly or indirectly contacted contaminated media and is known or suspected of being contaminated with oil, grease, polynuclear aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), or other hard to remove organic materials, rinse equipment with pesticide-grade isopropanol.
6. To the extent possible, allow components to air dry.
7. Wrap or cover equipment in clear plastic until it is time to be used.
8. All wastewater from decontamination procedures should be containerized.

2.3 BOREHOLE SOIL SAMPLING DOWNHOLE EQUIPMENT DECONTAMINATION

All soil sampling downhole equipment should be decontaminated before use and after each sample as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Prior to sampling, scrub the split-barrel sampler and sampling tools in a wash bucket or tub using a stiff, long bristle brush and Liquinox or Alconox solution.
4. After sampling, steam clean the sampling equipment over the rinsate tub and allow to air dry.
5. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
6. Containerize all water and rinsate; disposable single-use sampling equipment should also be containerized.
7. Decontaminate all equipment placed down the hole as described for drilling equipment.

2.4 WATER LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION

Field personnel should decontaminate the well sounder and interface probe before inserting and after removing them from each well. The following decontamination procedures should be used:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Wipe the tape and probe with a disposable Alconox- or Liquinox-impregnated cloth or paper towel.
4. If immiscible layers are encountered, the interface probe may require steam cleaning or washing with pesticide-grade isopropanol.
5. Rinse with deionized water.

2.5 GENERAL SAMPLING EQUIPMENT DECONTAMINATION

All nondisposable sampling equipment should be decontaminated using the following procedures:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. To decontaminate a piece of equipment, use an Alconox wash; a tap water wash; a solvent (isopropanol, methanol, or hexane) rinse, if applicable, or dilute (0.1 N) nitric acid rinse, if applicable; a distilled water rinse; and air drying. Use a solvent (isopropanol, methanol, or hexane) rinse for grossly contaminated equipment (for example, equipment that is not readily cleaned by the Alconox wash). The dilute nitric acid rinse may be used if metals are the analyte of concern.
4. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
5. Containerize all water and rinsate.

2.6 GROUNDWATER SAMPLING EQUIPMENT

The following procedures are to be employed for the decontamination of equipment used for groundwater sampling. Decontamination is not necessary when using disposable (single-use) pump tubing or bailers. Bailer and downhole pumps and tubing decontamination procedures are described in the following sections.

2.6.1 Bailers

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Evacuate any purge water in the bailer.
4. Scrub using soap and water and/or steam clean the outside of the bailer.
5. Insert the bailer into a clean container of soapy water. Thoroughly rinse the interior of the bailer with the soapy water. If possible, scrub the inside of the bailer with a scrub brush.
6. Remove the bailer from the container of soapy water.
7. Rinse the interior and exterior of the bailer using tap water.
8. If groundwater contains or is suspected to contain oil, grease, PAH, PCB, or other hard to remove organic materials, rinse equipment with pesticide-grade isopropanol.
9. Rinse the bailer interior and exterior with deionized water to rinse off the tap water and solvent residue, as applicable.
10. Drain residual deionized water to the extent possible.
11. Allow components to air dry.
12. Wrap the bailer in aluminum foil or a clean plastic bag for storage.
13. Containerize the decontamination wash waters for proper disposal.

2.6.2 Downhole Pumps and Tubing

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Evacuate any purge water in the pump and tubing.
4. Scrub using soap and water and/or steam clean the outside of the pump and, if applicable, the pump tubing.
5. Insert the pump and tubing into a clean container of soapy water. Pump/run a sufficient amount of soapy water to flush out any residual well water. After the pump and tubing are flushed, circulate soapy water through the pump and tubing to ensure that the internal components are thoroughly flushed.
6. Remove the pump and tubing from the container.
7. Rinse external pump components using tap water.
8. Insert the pump and tubing into a clean container of tap water. Pump/run a sufficient amount of tap water through the pump to evacuate all of the soapy water (until clear).
9. If groundwater contains or is suspected to contain oil, grease, PAH, PCB, or other hard to remove organic materials, rinse the pump and tubing with pesticide-grade isopropanol.
10. Rinse the pump and tubing with deionized water to flush out the tap water and solvent residue, as applicable.
11. Drain residual deionized water to the extent possible.
12. Allow components to air dry.
13. For submersible bladder pumps, disassemble the pump and wash the internal components with soap and water, rinse with tap water, isopropanol (if necessary), and deionized water, and allow to air dry.
14. Wrap pump and tubing in aluminum foil or a clean plastic bag for storage.
15. Containerize the decontamination wash waters for proper disposal.

3.0 INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) can include disposable single-use PPE and sampling equipment, soil cuttings, and decontamination wash waters and sediments. Requirements for waste storage may differ from one facility to the next. Facility-specific directions for waste storage will be provided in project-specific documents, or separate direction will be provided by the project manager. The following guidelines are provided for general use:

1. Assume that all IDW generated from decontamination activities contains the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. Waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.
2. Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility.
3. Label IDW storage containers with the facility name and address, date, contents, company generating the waste, and an emergency contact name and phone number.
4. Temporarily store the IDW in a protected area that provides access to the containers and allows for spill/leak monitoring, sampling of containers, and removal following determination of the disposal method.